DO NOT REMOVE FROM LIBRARY

620.6

William P. Morse

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XXXVI—No. 6

PRESENTED TO
N CIVIL
ENGINEERING SOCIETY
BY
WILLIAM P. MORSE

August, 1910

Published at the House of the Society, 220 West Fifty-seventh Street, New York, the Fourth Wednesday of each Month, except June and July.

Copyrighted 1910, by the American Society of Civil Engineers.

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XXXVI—No. 6

AUGUST, 1910

Edited by the Secretary, under the direction of the Committee on Publications.

Reprints from this publication, which is copyrighted, may be made on condition that the full title of Paper, name of Author, page reference, and date of presentation to the Society, are given.

CONTENTS

Society Affairs..........................Pages 265 to 394.
Papers and Discussions ....Pages 935 to 1206.

NEW YORK 1910.

Entered according to Act of Congress, in the year 1910, by the American Society of Civil Engineers, in the office of the Librarian of Congress, at Washington.

American Society of Civil Engineers

OFFICERS FOR 1910

President, JOHN A. BENSEL

Vice-Presidents

Term expires January, 1911:	*Term expires January, 1912:*
GEORGE H. PEGRAM	JOHN T. FANNING
EMIL SWENSSON	HUNTER McDONALD

Secretary, CHARLES WARREN HUNT

Treasurer, JOSEPH M. KNAP

Directors

Term expires January, 1911:	*Term expires January, 1912:*	*Term expires January, 1913:*
CHARLES L. HARRISON	FRANCIS LEE STUART	WILLIAM E. BELKNAP
GEORGE W. KITTREDGE	SAMUEL C. THOMPSON	HORACE LOOMIS
DEXTER BRACKETT	WILLIAM G. WILKINS	GEORGE A. KIMBALL
HORACE ANDREWS	ARTHUR N. TALBOT	PERCIVAL ROBERTS, Jr.
GARDNER S. WILLIAMS	WILLIAM M. GARDNER	CHARLES F. LOWETH
CHARLES S. CHURCHILL	HORACE A. SUMNER	ARTHUR DeWINT FOOTE

Assistant Secretary, T. J. McMINN

Standing Committees

(The President of the Society is *ex-officio* Member of all Committees)

On Finance:	*On Publications:*	*On Library:*
GEORGE H. PEGRAM	C. L. HARRISON	GEORGE W. KITTREDGE
CHARLES S. CHURCHILL	HORACE ANDREWS	DEXTER BRACKETT
GEORGE A. KIMBALL	WILLIAM E. BELKNAP	JOHN T. FANNING
HORACE LOOMIS	FRANCIS LEE STUART	HUNTER McDONALD
WILLIAM G. WILKINS	EMIL SWENSSON	CHAS. WARREN HUNT

Special Committees

On Uniform Tests of Cement: George S. Webster, Richard L. Humphrey, George F. Swain, Alfred Noble, Louis C. Sabin, S. B. Newberry, Clifford Richardson, W. B. W. Howe, F. H. Lewis.

On Rail Sections: Joseph T. Richards, C. W. Buchholz, E. C. Carter, S. M. Felton, Robert W. Hunt, John D. Isaacs, Richard Montfort, H. G. Prout, Percival Roberts, Jr., George E. Thackray, Edmund K. Turner, William R. Webster.

On Concrete and Reinforced Concrete: C. C. Schneider, J. E. Greiner, W. K. Hatt, Olaf Hoff, Richard L. Humphrey, Robert W. Lesley, Emil Swensson, A. N. Talbot, Joseph R. Worcester.

On Engineering Education: Desmond FitzGerald, Benjamin M. Harrod, Onward Bates, D. W. Mead, Charles Hansel.

On Steel Columns and Struts: Austin L. Bowman, Alfred P. Boller, Emil Gerber, Charles F. Loweth, Ralph Modjeski, Frank C. Osborn, George H. Pegram, Lewis D. Rights, George F. Swain, Emil Swensson, Joseph R. Worcester.

On Bituminous Materials for Road Construction: W. W. Crosby, A. W. Dean, H. K. Bishop, A. H. Blanchard.

◆

The House of the Society is open from 9 a. m. to 10 p. m. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

House of the Society—220 West Fifty-seventh Street, New York.

Telephone Number..................5913 Columbus.
Cable Address..................."Ceas, New York."

Vol. XXXVI. AUGUST, 1910. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

SOCIETY AFFAIRS

CONTENTS

Minutes of Meetings:

PAGE
- Of the Society, May 18th and June 1st, 1910 265
- Forty-second Annual Convention, June 21st-24th, 1910 269
- Elections and Transfers by the Board of Direction, June 30th, 1910 270
- Of the Board of Direction, May 31st, June 21st and 30th, 1910 273
- Report in full of the Business Meeting, June 21st, 1910, at the Forty-second Annual Convention 274
- Excursions and Entertainments during the Forty-second Annual Convention 308
- Attendance at the Forty-second Annual Convention 310

Announcements:

- Hours during which the Society House is open 315
- Future Meetings 315
- Searches in the Library 315
- Papers and Discussions 316
- Subscription Price to the Publications of the Society 316
- Local Associations of Members of the American Society of Civil Engineers 317
- Privileges of Engineering Societies Extended to Members 318

Accessions to the Library:

- Donations 321
- By Purchase 327

Membership (Additions, Changes of Address, Deaths) 330
Recent Engineering Articles of Interest 352

MINUTES OF MEETINGS

OF THE SOCIETY

May 18th, 1910.—The meeting was called to order at 8.30 P. M.; W. E. Belknap, Director, in the chair; Chas. Warren Hunt, Secretary; and present, also, 160 members and 16 guests.

A paper by J. C. Meem, M. Am. Soc. C. E., entitled "Pressure Resistance and Stability of Earth," was presented by the author and illustrated with lantern slides.

The subject was discussed by Messrs. T. Kennard Thomson, C. E. Gregory, Alexander C. Chenoweth, and Francis W. Perry, and the Secretary read a communication from E. P. Goodrich, M. Am. Soc. C. E.

The Secretary announced the following deaths:

JOSEPH PALMER FRIZELL, elected Member January 3d, 1883; died May 4th, 1910.

WILLIAM STORRS MACHARG, elected Member December 2d, 1903; died May 6th, 1910.

JOHN HENDERSON SAMPLE, elected Member October 6th, 1886; died March 4th, 1910.

ARCHIBALD ALEXANDER SPROUL, elected Member May 1st, 1907; died April 26th, 1910.

LUTHER ELMAN JOHNSON, elected Junior September 6th, 1904; died March 23d, 1910.

Adjourned.

June 1st, 1910.—The meeting was called to order at 8.30 P. M.; President J. A. Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, 139 members and 7 guests.

The minutes of the meetings of April 20th and May 4th, 1910, were approved as printed in the *Proceedings* for May, 1910.

A paper by E. B. Temple, M. Am. Soc. C. E., entitled "The New York Tunnel Extension of the Pennsylvania Railroad. Meadows Division and Harrison Transfer Yard," was presented by title.

A paper by B. H. M. Hewett and W. L. Brown, Members, Am. Soc. C. E., entitled "The New York Tunnel Extension of the Pennsylvania Railroad. The North River Tunnels," was presented by James Forgie, M. Am. Soc. C. E., and illustrated with lantern slides.

The Secretary announced the election of the following candidates by the Board of Direction on May 31st, 1910:

AS MEMBERS.

FREDERICK HAGUE AVERY, Chicago, Ill.
WILLIS EDWARD AYRES, Memphis, Tenn.
LOUIS PHILIP BLUM, Pittsburg, Pa.
WALTER HENRY BROWN, San Bernardino, Cal.
GEORGE CONRAD DIEHL, Buffalo, N. Y.
ARTHUR HERBERT DIMOCK, Seattle, Wash.
EDWARD HENRY HOWARD, Quincy, Mass.
ELVIN ULYSSES LEH, Cowell, Cal.
ARCHIBALD BYRON LUEDER, Morristown, N. J.
JOHN DUNCAN MACVICAR, Missoula, Mont.
ERNEST MCCULLOUGH, Evanston, Ill.
REN BROWN PERRINE, South Bend, Ind.
THOMAS TUPPER WHITTIER, New York City.

AS ASSOCIATE MEMBERS.

HARRY R. ANDRESS, Memphis, Tenn.
FREDERIC EUGENE AYER, Cincinnati, Ohio.

John Clark Bentley, Middletown, N. Y.
Joseph Bourguignon, Flushing, N. Y.
Henry Burdett Cleveland, Albany, N. Y.
David Augustus Daly, Mandan, N. Dak.
Guy Ellsworth Dobson, Portland, Ore.
Dorsey Berry Duncan, Columbia, Mo.
James Raymond Fitzpatrick, Grand Rapids, Mich.
Albert Wesley Gaumer, Firmeza, Cuba.
Joseph Alexander Grant, Montreal, Que., Canada.
Archie Lee Harris, Phœnix, Ariz.
David Walker Hays, Reno, Nev.
Harold Ezra Hilts, New Rochelle, N. Y.
Walter Clark Howe, Oakland, Cal.
Edward Orris Keator, Cincinnati, Ohio.
William Ambrose Kinsey, Newark, N. J.
Arnold Henry Krone, Baltimore, Md.
Walter Hills Law, Bridgeport, Conn.
John Martin, New York City.
Louis Charles Frederick Metzger, St. Louis, Mo.
Walter Edward Miller, Madison, Wis.
Cyrus Edward Minor, Cananea, Sonora, Mexico.
Louis Adolph Mitchell, Flushing, N. Y.
Oliver Moorshead, Newton, Kans.
Leo Thomas Peden, Houston, Tex.
Fred Elmer Rightor, El Paso, Tex.
Rollin Ritter, Blackrock, N. Mex.
Philip Schuyler, Berkeley, Cal.
George Blair Sturgeon, Berkeley, Cal.

As Associate.

William John Charles Kenyon, Chicago, Ill.

As Juniors.

Russell Vincent Banta, Ridgewood, N. J.
Howard Fred Bell, Jefferson, Ohio.
Charles Fowler Bornefeld, Galveston, Tex.
Otto George Henry Buettner, New York City.
Lester Lyman Coleman, San Francisco, Cal.
Jay Allen Craven, Chicago, Ill.
Laurence Brodhead Croasdale, Las Cruces, N. Mex.
William Chester Emigh, North Adams, Mass.
Harry Spear Harding, Walden, N. Y.
Harry William Henes, Chicago, Ill.
Roger Tifft Holloway, New York City.
James Francis Murphy, Brown Station, N. Y.

George Washington Reese, Arkansas City, Ark.
Richard Francis Roberts, New Haven, Conn.
Hugo Conrad Soest, New York City.
Ralph Edgar Spaulding, Worcester, Mass.
Richards Merle Strohl, Manila, Philippine Islands.
Frank Clifton Tolles, Louisville, Ky.
Rodney Melledge Wilson, New Rochelle, N. Y.

The Secretary announced the transfer of the following candidates by the Board of Direction on May 31st, 1910:

From Associate Member to Member.

William Brokaw Bamford, Trenton, N. J.
Joseph Patrick Carlin, New York City.
William Durward Connor, Washington, D. C.
Frank Arnold Hastings, Martins Ferry, Ohio.
Harry Hodgman, Amherstburg, Ont., Canada.
Robert Elmer Horton, Albany, N. Y.
Clifford Milton Leonard, Chicago, Ill.
Egbert Jessup Moore, New York City.
John Calvin Oakes, Cincinnati, Ohio.
Norman Salisbury Sprague, Pittsburg, Pa.
Orrin Elmore Stanley, Celilo, Ore.
Alfred Yngve Sundstrom, City of Mexico, Mexico.
Edward Beaumont Wardle, New York City.
John Bertram Wright, Amsterdam, N. Y.

From Junior to Associate Member.

David Adams Calhoun, New York City.
Howard Carlton Ford, Ames, Iowa.
Charles Edward Hayes, Babb, Mont.
Cuyler Warfield Lush, Rye, N. Y.
William Vincent McMenimen, Jersey City, N. J.
Melvin S. Rich, Washington, D. C.
Albert Otis True, Albany, N. Y.
LeRoy Duncan Williams, Macon, Mo.

The Secretary announced the following deaths:

John Edwards McKay, elected Member July 5th, 1893; died May 13th, 1910.

Albert Mather Smith, elected Member May 5th, 1886; died February 27th, 1910.

Adjourned.

FORTY-SECOND ANNUAL CONVENTION, HELD IN CHICAGO, ILL., JUNE 21ST-24TH, 1910

FIRST SESSION*

Tuesday, June 21st, 1910.—The meeting was called to order at 10 A. M.; President John A. Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, about 150 members and many guests.

The President introduced Dr. W. A. Evans, Health Commissioner, who, in behalf of the Mayor, welcomed the Society to Chicago.

At the conclusion of Dr. Evans' remarks, the President delivered the Annual Address.†

BUSINESS MEETING

Second Session of the Convention, Tuesday, June 21st, 1910.—At the conclusion of the President's Address, the Business Meeting was convened; President John A. Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, about 150 members and many guests.

The Secretary presented the Report of the Board of Direction in reference to the proposal to appoint a Special Committee to Report on the Preservation of Wood.‡

A motion, duly seconded, to refer the matter to letter-ballot of the Society was lost by a vote of 74 to 43.

The Secretary presented a report giving the result of the suggestions of members as to the Time and Place for holding the Annual Convention of 1911.§

On motion, duly seconded, the matter of the selection of the Time and Place for holding the next Annual Convention was referred to the Board of Direction, with power.

The Secretary presented a report from the Special Committee on Rail Sections, in which the Committee requested to be discharged.||

On motion, duly seconded, the report was accepted and the Committee discharged.

The Secretary presented the Report of a Committee of the Board of Direction appointed to formulate the general lines which should be followed in legislation affecting the practice of engineers.¶

On motion, duly seconded, the report was accepted.

Adjourned.

---

* For the report in full of this and the Business Meeting, see page 274.

† See page 277.

‡ See page 282.

§ See page 287.

|| See page 291.

¶ See page 299.

Third Session, Tuesday, June 21st, 1910.—The meeting was called to order at 8.30 P. M. in the Gold Room of the Congress Hotel; President John A. Bensel in the chair; Chas. Warren Hunt, Secretary, and present, also, many members and guests.

Alfred Noble, Past-President, Am. Soc. C. E., described the New York Tunnel Extension of the Pennsylvania Railroad, illustrating his remarks with lantern slides.

Adjourned.

Fourth Session, Wednesday, June 22d, 1910.—The meeting was called to order in the Congress Hotel at 8.30 P. M.; President John A. Bensel in the chair; Chas. Warren Hunt, Secretary, and present, also, many members and guests.

J. Waldo Smith, M. Am. Soc. C. E., described the new water supply for the City of New York, illustrating his remarks with lantern slides.

Adjourned.

Fifth Session, Thursday, June 23d, 1910.—The meeting was called to order in the Congress Hotel at 8.30 P. M.; President John A. Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, many members and guests.

The plans recently perfected for beautifying the City of Chicago were described and illustrated by D. H. Burnham, Esq.

Adjourned.

ELECTIONS AND TRANSFERS BY THE BOARD OF DIRECTION, JUNE 30TH, 1910

As Members.

Osgood Frost Barnes, Susquehanna, Pa.
Arthur Allen Booth, Spokane, Wash.
Emott Davis Buel, Westbury, N. Y.
Frank Henry Hamilton, Springfield, Ill.
Frederic Robert Harris, Brooklyn, N. Y.
Warren Albert Hoyt, Riverside, Ill.
John Wilbur Hughes, Schenectady, N. Y.
William Nickels Patten, Boston, Mass.
Theodore Alfred Straub, Pittsburg, Pa.
James Irving Vincent, New York City.
Bertrand Thorp Wheeler, Boston, Mass.
Louis Peter Wolff, St. Paul, Minn.

As Associate Members.

Guy Burnet Bebout, Wheeling, W. Va.
Frank David Chase, Chicago, Ill.
John Wesley Cornell, Chicago, Ill.

Jay Bosworth Dawson, Los Angeles, Cal.
George Myron Demorest, Canton, Ohio.
Raffe Emerson, Bethlehem, Pa.
Leon Goodman, Des Moines, Iowa.
Edgar Morton Hastings, Richmond, Va.
Charles Frank Healey, Tacoma, Wash.
Robert Sharp Jones, Columbus, Ohio.
Joseph Vance McNary, Pittsburg, Pa.
Howard Chester Means, Ft. Duchesne, Utah.
Robert Brooks Morse, Baltimore, Md.
John Nagel, Manhattan Beach, N. Y.
Walter Hilliard Nicol, Tuscaloosa, Ala.
Joseph Matthew O'Hara, San Francisco, Cal.
Frederic Hatheway Peters, Calgary, Alta., Canada.
William Thomas Shaw, Boston, Mass.
Zenas Harrison Sikes, Yonkers, N. Y.
Constantine Kenneth Smoley, Scranton, Pa.
Frank Norton Spencer, Toledo, Ohio.
Harold Converse Stevens, New York City.
Harry Herschel Weinstock, New York City.

As Associate.

Joseph Henry Brown, Jr., New York City.

As Juniors.

Arthur Pope Ackerman, Vail Gate, N. Y.
Frank Leonard Bolton, Rochester, N. Y.
Richard Lucius Cary, Boston, Mass.
Keyes Christopher Gaynor, Sioux City, Iowa.
Charles Lacey Hall, Washington Barracks, D. C.
Joseph Emmett Hall, Indianapolis, Ind.
Milo Clinton Halsey, Niagara Falls, Ont., Canada.
John George Hirsch, Madison, Wis.
Thomas Leach, Beaver Falls, Pa.
Ray Webb McMullen, New York City.
José Justo Manzanilla y Carbonell, Havana, Cuba.
Charles Reed Marsh, Boston, Mass.
Raymond Washington Parlin, Boston, Mass.
Alonzo Orrin Peabody, Medina, N. Y.
Charles Henry Shapleigh, Jackson, Miss.
Francis Marion Terry, Ft. Worth, Tex.
Ellwood Coggeshall Wilder, New York City.

Transfers from Associate Member to Member.

Lorenzo Dana Cornish, Culebra, Canal Zone, Panama.
James William Elliott, Hamilton, Ont., Canada.

Robert Olcott Hayt, Helena, Mont.
Richard Willis How, Jamaica, N. Y.
Thomas Courtney Moorshead, Alton, Ill.
Clyde Potts, New York City.
Charles Henry Quimby, Jr., Mt. Vernon, N. Y.
William Everett Swift, Cornwall-on-Hudson, N. Y.
Ezra Bailey Whitman, Colgate, Md.
William Edward Wilson, Buffalo, N. Y.

Transfer from Associate to Associate Member.

Leslie Abram Waterbury, Tucson, Ariz.

Transfers from Junior to Associate Member.

Eugene Harry Bruntlett, Minneapolis, Minn.
Harry Lewis Coyne, New York City.
Edward Crow, Wanganui, New Zealand.
Henry Haydock Garrigues, Kittanning, Pa.
Robert Elliot Hall, Auburn, N. Y.
Warren Esterly Hall, Guayama, Porto Rico.
Eliot Nichols Smith, Poughkeepsie, N. Y.
Arthur Linville Terry, Jr., Philadelphia, Pa.

OF THE BOARD OF DIRECTION

(Abstract)

May 31st, 1910.—President Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Belknap, Kimball, Loomis, Loweth, Pegram, Roberts, Stuart, Swensson, and Thompson.

A report of the Board for presentation to the Annual Convention, in the matter of the proposed appointment of a Special Committee on the Preservation of Wood, was adopted.

Ballots for membership were canvassed resulting in the election of 13 Members, 30 Associate Members, 1 Associate, and 19 Juniors, and the transfer of 8 Juniors to the grade of Associate Member.

Fourteen Associate Members were transferred to the grade of Member.

Applications were considered and other routine business transacted.

Adjourned.

June 21st, 1910.—The Board met, as required by the Constitution, at the Annual Convention at Chicago, Ill., at 12.15 P. M., June 21st, 1910, President Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Bates, Fanning, Loweth, Pegram, Schneider, Swensson, Talbot, and Williams.

There being no business to be brought to its attention, the Board adjourned.

June 30th, 1910.—A Special Meeting of the Board to canvass ballots for membership and to consider applications for membership was held at 8.40 P. M., June 30th, 1910, Vice-President Pegram in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Belknap, Brackett, Kimball, Knap, Loomis, Schneider, Stuart, Talbot, and Thompson.

Ballots for membership were canvassed resulting in the election of 12 Members, 23 Associate Members, 1 Associate, and 17 Juniors, and the transfer of 8 Juniors to the grade of Associate Member.

Ten Associate Members were transferred to the grade of Member, and 1 Associate to the grade of Associate Member.

Applications were considered.

Adjourned.

REPORT IN FULL OF THE FIRST SESSION OF THE FORTY-SECOND ANNUAL CONVENTION, AND OF THE BUSINESS MEETING, HELD IN THE GOLD ROOM OF THE CONGRESS HOTEL, CHICAGO, ILL.

FIRST SESSION

Tuesday, June 21st, 1910.—The meeting was called to order at 10 A. M.; John A. Bensel, President, in the chair; Charles Warren Hunt, Secretary; and present, also, about 150 members and many guests.

THE PRESIDENT.—Ladies and Gentlemen, I take pleasure in introducing to you Doctor W. A. Evans, Health Commissioner of the City of Chicago.

Address of Welcome.

DR. W. A. EVANS. Mr. President, Ladies and Gentlemen, I am here at the request of the Mayor. Your Committee on Arrangements waited upon Mayor Busse, and asked him to come over to this meeting this morning to assure you that you were welcome in the City of Chicago. It was not possible for him to be present. It is a custom of his (from which he does not depart) not to attend functions of this character, and, in consequence, in that he is not here to welcome you personally to-day, you are not being slighted. It is his custom rather to delegate this function to officials, members of his cabinet, and I have been delegated to express Chicago's welcome to you.

There is some fitness in this delegated authority, a fitness quite aside from the person who is to speak. The fitness rests in the fact that I am in charge of the Health Department of this city, and that, by reason of this fact, I understand something of the importance of your deliberations, something of what it means to society, to government, and to humanity, to have you come to this city and discuss the great questions that are to be the subject of your deliberations.

A few years ago, in all probability, this duty would have been delegated to the Commissioner of Public Works, and I do not say that there would not be fitness in such delegation at the present time, but the trend of affairs is toward a public and universal recognition of the fact that your work is coming closely in touch with the work of the Health Department.

Until I came into this work, my experience with organizations had been largely limited to meetings of physicians. I came to have an insularity from those meetings. I came to believe that there was no work that was quite as important to society as the work of the medical men—work done in private and work done in the course of the meetings of their deliberative organizations. Soon after I had come in touch with this work I was variously delegated to attend meetings, and I got a larger view and saw that, in various parts of society, there were men striving earnestly and conscientiously to do things advantageous for themselves and for the betterment of their kind. Since that time I have come to understand that there was not this separateness that I had first believed between the work of these various groups of men, and that the work in general did not differ largely from the work of the medical men and of the health officers.

In this country, until a few years ago, there was quite an universal drifting toward taking advantage of the blessings that God had bestowed, making use of the unparalleled opportunities that this nation offered, holding each day as sufficient unto itself, and looking not to the morrow. That which we are now coming to understand is that all down the line there must be planning, and, in consequence, the old wooden railroad bridge has been superseded by a structure that is built for to-morrow.

Governments, also, are recognizing the fact that after Saturday will come Sunday, and that each day is but one in a procession of days, and so municipal authorities are not only putting down pavements, but they are putting down good pavements; they are not studying to lay pavements or to build sewers for to-day, but they are studying how they can best build sewers that will be commodious and effective for the generations that come after, for the days that will follow to-day and even for the days that will follow to-morrow. We are coming to understand that medical men are not fulfilling their full duty when they cure the patient who is already sick; that there are great economics involved; and if it is a fact that the annual cost of illness in this nation each year is a billion and a half of dollars and that one-third of this can be saved, namely, five hundred million dollars, that it is worth while that men should plan to make this saving.

We are coming to understand that it is uneconomic and unwise to have children grow up with bent bodies and crooked limbs, pale and wan, and weak, and that a nation cannot permanently prosper that does not develop this greatest national asset, namely, the health, and strength, and vigor, and force of those who make up its citizenship.

In this great work you and my people are one, in that engineers are striving to develop that which is best in building, to the end that buildings may be permanent rather than transient. You are striving to plan; and in this great planning of government, of methods of municipalities, of methods of individuals, if you will, and society building, you are the leaders.

You have thought on these great problems of planning for the

Address of Welcome (continued).

future, years before they became subjects of common thought on the part of the people at large, and that which the newspapers are blazoning forth as something new, new principles and new methods in government and society life, are things that you discovered decades ago, and the things which people are now just beginning to think of and to plan concerning, are the things that you have been thinking of and planning until the story is with you not new but old. Believing these things, gentlemen, recognizing these things, you can understand how we feel toward this meeting that is to be held here in the City of Chicago.

You are to mingle pleasure with profit, and we trust that out of your visit there will come enjoyment in every function that your local committee has provided for you. We trust that through your scientific and deliberative sessions, there will come profit, profit for all parts of this land, and that men everywhere, and that governments everywhere, and enterprises everywhere in this country will be better worked out for the deliberations conducted by you. I say that we are glad to have you discharge this duty in this community, and the reason is this: In the discharge of them, in the good that you are to spread around all over this country, in the beneficence that will flow to all parts of this land from your work, there will be some part of it for Chicago. In view of our proximity, we verily believe that we will get from it more than we will give to you, and more than will flow from it to any other part of this country.

We believe that from your meetings here we will learn something as to the various engineering features that concern our people in the different parts of the government and in the different things that concern their daily life.

Therefore, in the name of the Department of Health of this city—more than that—in the name of the Mayor and the city government of this city—and furthermore than that—in the name of the people of the City of Chicago, I bid you welcome here. (Applause.)

J. A. Ockerson, M. Am. Soc. C. E.—Mr. Chairman, I move that the American Society of Civil Engineers, in convention assembled, send greetings to the Mayor of the City of Chicago, and express its profound appreciation of the very cordial welcome extended by the Mayor's official representative. I move the adoption of the motion by a rising vote.

(The motion, being duly seconded, was carried unanimously by a standing vote.)

ANNUAL ADDRESS

JOHN A. BENSEL, PRESIDENT.

President's Annual Address.

I know that to some of my audience a satisfactory address at a summer convention would be like that which many people regard as a satisfactory sermon—something soothing and convincing, to the effect that you are not as other men are, but better. While I appreciate very fully, however, the honor of being able to address you, I am going to look trouble in the face in an effort to convince you that, in spite of great individual achievements, engineers are behind other professional men in professional spirit, and particularly in collective effort.

Whether this, if true, is due to our extreme youth as a profession, or our extreme age, is dependent upon the point of view; but I think it is a fact that will be admitted by all that engineers have not as yet done much for their profession, even if they have done considerable for the world at large.

Looking backward, our calling may properly be considered the oldest in the world. It is older, in fact, than history itself, for man did not begin to separate from the main part of animal creation, until he began to direct the sources of power in Nature for the benefit, if not always for the improvement, of his particular kind. In Bible history, we find early mention of the first builder of a pontoon. This creditable performance is especially noted, and the name of the party principally concerned prominently mentioned. The same thing cannot be said of the unsuccessful attempt at the building of the first skyscraper, for here the architect, with unusual modesty, has not given history his name, this omission being possibly due to the fact that the building was unsuccessful. If an engineer was employed on this particular undertaking, the architect had, even at that early stage of his profession, learned the lesson of keeping all except his own end of the work in the background.

The distinctive naming of our profession does not seem, however, to go back any farther than the period of 1761, when that Father of the Profession, John Smeaton, first made use of the term, "engineer," and later, "civil engineer," applying it both to others and to himself, as descriptive of a certain class of men working along professional lines now existing and described by that term.

Remarkable progress has certainly been made in actual achievements since that time, and I know of nothing more impressive than

President's Address (continued).

to contemplate the tremendous changes that have been made in the material world by the achievements of engineers, particularly in the last hundred years. This was forcibly impressed upon me a short time ago, while in the company of the late Charles Haswell, then the oldest member of this Society, who, seing one of the recently built men-of-war coming up the harbor, remarked that he had designed the first steamship for the United States Navy. The evolution of this intricate mass of mechanism, which, from the very beginning of its departure from the sailing type of vessel, has taken place entirely within the working period of one man's life, is as graphic a showing of engineering activity as I think can be found.

Our activities are forcibly shown in many other lines of invention and in the utilization of the forces of Nature, particularly in the development of this country. We, although young in years, have become the greatest railroad builders in history, and have put into use mechanical machines like the harvester, the sewing machine, the telephone, the wireless telegraph, and almost numberless applications of electricity. Ships have been built of late years greatly departing from those immediately preceding them, so that at the present time they might be compared to floating cities with nearly all a city's conveniences and comforts. We have done away with the former isolation of the largest city in the country, and have made it a part of the main land by the building of tunnels and bridges. In all our work it might be said that we are hastening, with feverish energy, from one problem to another, for the so-called purpose of saving time, or for the enjoyment of some new sensation; and we have also made possible the creation of that which might be deemed of doubtful benefit to the human race, that huge conglomerate, the modern city.

There has been no hesitancy in grappling with the problems of Nature by engineers, but they seem to be diffident and neglectful of human nature in their calculations, leaving it out of their equations, greatly to their own detriment and the world's loss. We can say that matters outside of the known are not our concern, and we can look with pride at our individual achievements, and of course, if this satisfies, there is nothing more to be said. But it is because I feel that engineers of to-day are not satisfied with their position, that I wonder whether we have either fulfilled our obligations to the community, or secured proper recognition from it; whether, in fact, the engineer can become the force that he should be, until he brings something into his equations besides frozen figures, however diverting an occupation this may be.

One may wonder whether this state of affairs is caused from a fear of injecting uncertain elements into our calculations, or whether it is our education or training which makes us conservative to the point of operating to our own disadvantage. We may read the requirements of our membership and learn from them that in our accomplishments we are not to be measured as skilled artisans, but the fact remains that, to a great extent, society at large does so rate us, and it would seem that we must ourselves be responsible for this state of affairs. Our colleges and technical schools are partly to blame for the existence of this idea, on account of the different degrees which they give. We have a degree of civil engineer, regarded in its narrowest sense, of mining engineer, mechanical engineer, electrical engineer, and by necessity it would seem as if we should shortly add some particular title to designate the engineer who flies. In reality there should be but two classes of engineers, and the distinction should be drawn only between civil engineers and military engineers. As a matter of fact, fate and inclination determine the specialty that a man takes up after his preliminary training, and so far as the degrees are concerned, the only one that has any right to carry weight, because it is a measure of accomplishment, is that which is granted by this Society to its corporate members. The schools, in their general mix-up of titles, certainly befog the public mind. It is as if the medical schools, for instance, should issue degrees at graduation for brain doctors, stomach doctors, eye and ear doctors, etc. Very wisely, it seems to me, the medical profession and the legal profession, with histories far older than ours, and with as wide variations in practice as we have, leave the variations in name to the individual taste of the practitioner, in a manner which we would do well to copy. The Society itself has adopted very broad lines in admission to membership, classing as civil engineers all who are properly such; and there is good reason for the serious consideration of the term at this time, as we cannot fail to recognize a tendency in State and other governments to legislate as to the right to practice engineering. It was owing to the introduction of a bill limiting and prescribing the right to practice in the State of New York, that a committee was recently appointed to look into this matter and report to the Society. This report will be before you for action at this meeting.

President's Address (continued).

As to the manner in which engineers individually perform their work, no criticism would properly lie, and in fact it is fortunate that our work speaks for itself, for, as a body, we say nothing. We are no longer, however, found working for the greater part of the time on the outskirts of civilization, and it becomes necessary, therefore, for us to change with changing conditions, and to use our Society not only for the benefit of the profession as a whole, but for the benefit of the members individually. Whether one of our first steps in this direction should be along legislative lines is for you to determine. For myself, having been confronted with legislation recently attempted in New York, I am convinced that we shall have legislation affecting our members, and this legislation should properly be moulded by some responsible body like our own Society. If we do not take the matter up ourselves it is likely to be taken up by other associations, and from past experience, it would seem as though it might be carried on along lines that would tend to ridicule our desire for professional standing.

The Society is to be congratulated on its present satisfactory status. The reports show a very satisfactory financial condition, and you may note a continuing increase in membership that is extremely gratifying. This, after having nearly doubled in the last seven years, still shows no sign of diminishing in its rate of increase. It may be said, also, that we have in the Society an excellent publishing house, where the members have an opportunity to secure technical papers published in the highest style of the art. We have in general in the officers, a number of men, who, within the prescribed limits, labor for the benefit of the members, but we also have constitutional limitations to the activity of our governing body, so that the voice of the Society is never heard, or, at least, might be compared to that still, small voice we call "conscience," which is not audible outside of the body that possesses it.

Now, in these days, when the statement that two and two make four is accepted from its latest originator as a newly discovered truth, a little extension of our mathematics, to take into our estimate people as well as things, is what we principally need, and it would be a good thing, regarded either from the point of view of what the world needs or the more selfish view of our own particular gains. At the present time it would seem as though our world had thrown away the old gods without taking hold of any new ones. Private ownership as it formerly existed is no longer recognized; individual action in almost any large field is to-day hampered and curtailed in a manner undreamed of twenty years ago. In fact, our whole scheme of government seems to be passing from the representative form on which it was founded, to some new form as yet undetermined. Whether all this is, in our opinion, for good or for evil, is of no particular concern. The matter that concerns us is, that we have left our old moorings, and that, to secure new ones, new limits are to be set to the activities of men along lines which concern us, and that, therefore, it is necessary that those who by education and training are best fitted to consider facts and not desires, should guide society as much as possible along its new lines. I consider that we as a profession are particularly trained to do this by our consideration of facts as they exist, and I think it will be recognized by all that we are not in our work or activities bound by any precedent, even if we do learn all that we can from the past; and that we are by nature and training of a cool and calculating disposition, which is surely a thing that is needed in this time of many suggested experiments.

To be effective, however, we must be cohesive, and thus be able to take our part not as the led, but as leaders, convincing the people, if possible, that all the ills of our social system cannot be cured by remedies which neglect the forces of creation, and that the best doctors for our troubles are not necessarily those whose sympathies are most audibly expressed.

In the recent discoveries of science our ideas as to the forces of Nature must be greatly enlarged and our theories amplified. Recent discovery of radium and radio-active substances shows at least that much of our old knowledge needs re-writing along the lines of our greater knowledge of to-day.

With this increase of knowledge it would seem as though those who devote their lives to the exploitation of natural forces should take a position in the future even more prominent than in the past, and it will undoubtedly become our function to help the world to that ideal state described by our greatest living poet of action, when he speaks of the time to come, as follows:

> "And no one shall work for money,
>   And no one shall work for fame;
> But each for the joy of working,
>   And each in his separate star;
> Shall draw the thing as he sees it,
>   For the God of the things as they are."

BUSINESS MEETING

Business Meeting Called to Order.

The President.—The meeting is now open for business. The first item is the report of the Board of Direction in the matter of a proposed Special Committee to report upon the preservation of wood. The Secretary will read the report of the Board.

The Secretary.—I have been asked to make the following announcement: That there will be a meeting of the Nominating Committee at 7.45 p. m. to-day in Room 6.

The Secretary read the following report:

Report on Proposed Committee on Wood Preservation.

To the Members,
American Society of Civil Engineers:

In the matter of the proposal to appoint a Special Committee "to investigate and report on the preservation of wood," the Board of Direction, having given the subject careful consideration, is of the opinion that it is not advisable that a Special Committee of the Society be appointed for that purpose. In accordance with the requirements of the Constitution, arguments for and against the appointment of such a committee are submitted herewith.

Arguments in Favor.

The subject is most important and interesting to engineers engaged in building large structures where the use of heavy timbering is a large item, since this material is becoming more scarce and expensive every year. Any preservative processes that add to the life of timber should be eagerly sought for and adopted if found practicable within limits of cost. It would be of great benefit to the Society to receive progress reports from time to time as material therefor could be obtained. It appears that the records and recommendations of the Society as they now stand are based on data available previous to the year 1885, and that the Society offers nothing to its members based on the available experience of the twenty-five years which have elapsed since then. It is probable that the experience of the past quarter century would modify considerably the report of 1885 with regard to the processes then used, even if it did not indicate new ones. As the conclusions and recommendations of the Society hold high authority, it should not put itself on record on any subject unless it is prepared to follow and report the progress of such subject. A fair presumption being that this subject has progressed, an obligation to investigate further and report has obtained on the ground that such investigation will be beneficial even though its conclusions indicate no progress.

Arguments Against.

There are not sufficient data on hand on the subject to warrant new deductions or conclusions. The appointment of such a committee would only further the exploitation of new processes by those commercially interested, which processes are not well enough established to demonstrate their efficiency. The Railway Engineering and Maintenance of Way Association has a committee now working and reporting on this subject, the personnel of which is much better situated to deal with the subject comprehensively than engineers not connected with railroads. Twelve of the large railroad systems now have one or more wood preservation plants, and two other railroad systems are now building such plants. An efficient committee would necessarily include a number of engineers connected with these railroads who are already on the committee of the Railway Engineering and Maintenance of Way Association. The probable outcome of the appointment of another committee would be that the reports of the committee appointed by this Society would only largely reflect or repeat the conclusions of the committee already existing. Any committee appointed by this Society must necessarily await the reports or investigations of the Maintenance of Way Committee, for the reason that the original investigations which the members of this committee are giving to the subject are so important that they could not be neglected. In order to formulate conclusions of value or to express opinions upon methods, it is obviously necessary that there should be sufficient data on the subject under consideration to deal with the matter intelligently and more or less conclusively; this would involve original investigations, and the committee of this Society would not be able to undertake such investigations except on a very small scale.

By order of the Board of Direction.

CHAS. WARREN HUNT,
Secretary.

MAY 31ST, 1910.

Discussion on Appointment of Committee on Wood Preservation.

H. S. CROCKER, M. AM. SOC. C. E.—Mr. Chairman, I would like to make the following motion: The question of the appointment of a Special Committee to report upon the preservation of wood, having been brought to the attention of the Board of Direction at the instance of the Colorado Association of the Society, I desire to say, in behalf of our Association, that the project is one which we believe of sufficient importance to justify a careful investigation with a view to having literature collated and definite specifications or recommendations presented for the consideration of the members of the Society. Those of us who are actively interested in timber treatment feel that the question is a live one and worthy of serious consideration.

I, therefore, move that the question of the appointment of a Special Committee be referred to letter-ballot of the Society, or whatever method of procedure is correct.

(The motion was duly seconded.)

Discussion on Appointment of Committee on Wood Preservation (continued).

Walter Buehler, M. Am. Soc. C. E.—Mr. Chairman, the argument against the appointment of this committee—that there are not sufficient data—seems to be an argument for, rather than against, the appointment of the committee. If any engineers present have had occasion to draw up specifications or look into the subject of wood preservation, they will unquestionably agree with me that the literature on this subject is extremely scarce. The Congressional Library at Washington contains about three publications, one handbook and two trade publications. I believe I am right in stating that the Library of the American Society of Civil Engineers contains the same handbook referred to, written by Mr. Roe, the publications of the Wood Preservers' Association, and possibly the reports of the committee of the American Railway Engineering and Maintenance of Way Association, and also the report of the Society's committee of 1885. This committee was appointed, as I understand, in 1880, and it reported five years later. Octave Chanute, Past-President, Am. Soc. C. E., was chairman of that committee. That report stands to-day as probably the best piece of literature we have on the subject. It is twenty-five years old. The art of wood preservation has advanced greatly in the last twenty-five years; that art is closely linked with the question of forest preservation, and is one of extreme importance, not only to engineers, but to all. It would seem to me that part of the work of this Society would be to bring up the literature on this art from the report of the last committee to date. Since the report of that committee, probably five or six new processes have been introduced. Now, it strikes me that it will not be the work of this proposed committee to make recommendations, but rather to bring before the members of the Society the exact status of the art to-day. The American Railway Engineering and Maintenance of Way Association ordered its committee to take the matter up, and it is doing a great deal of work, but the province of that association's committee is not to bring up the work done in the past, but rather to state what work shall be done in the future. It is the detail work. It is the work of recommending methods of detail.

It would seem to me that we can only look into the future if we know what has been done in the past, and that the work of the Society should be to bring up this art from the report of 1885 to date.

A. L. Dabney, M. Am. Soc. C. E.—Mr. Chairman, may I ask what is the scope of this resolution which is before the house? I am not sure that I understand it clearly.

The President.—The resolution, as proposed and seconded, is that the matter of the appointment of a Special Committee be referred to letter-ballot of the Society.

Mr. Dabney.—I would like to ask, then, what that resolution does with the report of the Board.

The President.—I should say that it does not do very much except to wipe it out.

Mr. Dabney.—Then I think we had better take care of the report of the Board first.

The President.—I do not think the Board will feel very badly at any action the Society may take first.

Samuel Whinery, M. Am. Soc. C. E.—Mr. President, the functions of engineering committees in the American Society of Civil Engineers are not very clearly defined in our Constitution. The duties of such committees are necessarily somewhat limited to the collation, consideration, and classification of facts that may have been gathered in the profession, so that they may be scattered through the profession, and in that way bring about what may be considered to be the conclusion of the profession with regard to certain practices, specifications, and so forth. Unfortunately, our committees have never been in a position to make original investigations, and, without such investigations, intelligent and valuable reports on some of the engineering questions seem to be almost impossible. With some of the processes with which some engineers deal, a long time is required to reach any conclusion. Chemical experiments are of but little value. Short, quick experiments, such as can be made with cement, are of little value. If our experience with wood preservation proves anything, it proves that results are worth while. It proves that, however strongly a process may be recommended, whatever may be in its favor, nothing short of a test of years—and it requires many and many years—is necessary to give conclusive evidence as to the value of that particular process.

Now, in the matter of timber preservation, those who are familiar with the subject will recall that, up to perhaps a few years ago, the literature and practices and beliefs of the profession were fairly well crystallized. It was pretty generally understood that perhaps only two methods had survived the necessary tests of utility. Discussion was largely confined to the details of the application of these processes, how the treatment should be made, the quantity of cresote oil or chloride of zinc that should be used, and so forth; and upon these points the conclusion of a committee of this Society might be of value, collating, as it might, all the information available. In recent years, however, there has been quite a change in the whole status of the preservative treatment of timber. A number of new processes have been brought to the notice of the public, some of them exceedingly promising, and supported, so far as we can now judge, by sound evidence; but, as I remarked before, nothing but actual experience can test their value. No committee of this Society would be at the present time in a position to deal with these new processes. As far as relates to the older processes, about which it might classify and establish standards, it is true a committee might handle that well, but we

Discussion on Appointment of Committee on Wood Preservation (continued).

know practically all that is to be known on that particular branch to-day, perhaps; that is, the manipulation of the old and standard methods of treatment.

Now, it is represented to the profession to-day that the idea, which prevailed for a long time, that in the preservative treatment of timber some antiseptic was necessary, is wrong; that for certain purposes the presence of an antiseptic in the material for treating timber is not necessary; in other words, the deduction would be that to a certain extent the preservative treatment is a matter of preserving the pores in the wood from air and moisture. Now, probably that may be true. I do not think any of us are in a position to judge. No committee of this Society would be prepared to deal with that important subject until we have very much more information, and until we have the results of long experience or original research.

Therefore it seems that this Society should not undertake to formulate, through the committee or by other means, judgment or opinions on processes which are yet matters of experiment, and, unless this proposed committee takes up this branch of it, there would not be very much for it to do. Therefore I think the resolution offered should not be passed.

Mr. Dabney.—Mr. President, my effort is to get some clear idea of what is proposed to be done by this committee. It appears to me that the purpose is to collate all such information as is available up to date, so that all information and literature on the various processes of preservation of wood may be gathered, the result of experiments that have been made, and so forth.

Now, it seems to me that the appointment of such a committee would involve nothing very formidable, and that the Society would be providing in a methodical and authoritative way for the sum total of all the information of that character that is available to be collated and classified; and that such committeee might have its functions prolonged, and keep the Society informed from time to time of the progress that is being made along that line. That is rather an imperfect idea of what is being proposed to be done, but if that is it, I am inclined to favor the appointment of that committee.

The President.—Are there any further remarks?

A Member.—For information, I would like to ask if the appointment of that committee does away with the old committee?

The Secretary.—The old committee died many years ago, sir.

A Member.—Well, what are they reporting for?

The Secretary.—This report is a report of the Board of Direction. At a meeting of the Society, under the Constitution, this question of the appointment of a Special Committee on the preservation of wood was brought up at the instance of the Colorado Association of Members of the Society, and, on the vote of twenty-five members, the matter was referred to the Board of Direction for report. The Board of Direction had to report at the next general meeting. The following is the Constitutional provision:

"12.—Special committees to report upon engineering subjects shall be authorized, except as further provided in this paragraph, by a majority of the votes cast by the Society, and in the following manner: A proposition to appoint such a Committee shall be presented at a regular meeting of the Society, and if sustained, on a motion to refer the same to the Board of Direction, by an affirmative vote of not less than twenty-five Corporate Members, it shall be so referred.

"The Board of Direction shall then consider the same and report its recommendations to the Society at the next general business meeting, together with a statement of the arguments for and against the appointment of such Committee.

"If a motion for the issue of a letter-ballot thereon receive the affirmative vote of two-thirds of the Corporate Members present, the Board of Direction shall, within thirty days thereafter, issue the letter-ballot, accompanied by a statement of the arguments for and against the proposition."

THE PRESIDENT.—Then I think that, with this explanation, gentlemen, which has just been made by the Secretary, the subject will be well understood and that the Board of Direction, having made its report, and recommended that no committee be appointed, to do away with that recommendation it will be necessary for two-thirds of the corporate members here present to vote "aye" to Mr. Crocker's resolution. I therefore ask all to stand who vote "aye."

(The Secretary announced that 43 had risen.)

THE PRESIDENT.—All those voting "nay" will please rise.

(The Secretary announced that 74 had risen.)

THE PRESIDENT.—The motion is lost.

MR. DABNEY.—Mr. Chairman, I wish to state in explanation of my negative vote, after speaking in favor of the resolution, that I did not, until just before I voted, understand that this resolution was in opposition to the recommendation of the Board of Direction.

Convention of 1911.

THE PRESIDENT.—The next business in order is the Time and Place for holding the next Annual Convention. The Secretary will read his report.

THE SECRETARY.—This is simply a collation of the replies received, suggesting places and times for holding the next Annual Convention.

Report of the Secretary on Suggestions Received as to the Time and Place for Holding the Annual Convention, 1911

"I have the honor to report that in response to a circular issued by the Board of Direction asking for suggestions as to the time and place for holding the Annual Convention in 1911, suggestions have been received as follows:

Convention of 1911 (continued).

"As to the place:

"Total number of suggestions received, 401; divided as follows:

Saratoga, N. Y.	89	Los Angeles, Cal.	10
Panama Canal Zone	41	Atlantic City, N. J.	9
San Francisco, Cal.	21	Washington, D. C.	9
New Orleans, La.	18	Baltimore, Md.	8
Pittsburg, Pa.	16	Denver, Colo.	7
Seattle, Wash.	16	New York City	7
Boston, Mass.	13	Jacksonville, Fla.	5
Duluth, Minn.	12	Niagara Falls, N. Y.	5
Portland, Ore.	11	Ottawa, Canada	5
St. Louis, Mo.	11		

"The following places received 4 suggestions each:

Cleveland, Ohio.
Kansas City, Mo.
Toronto, Canada.
Steamer on Great Lakes.
No Preference.

"The following places received 3 suggestions each:

Minneapolis, Minn.
Montreal, Canada.
Quebec, Canada.
Salt Lake City, Utah.
St. Paul, Minn.

"The following places received 2 suggestions each:

Albany, N. Y.
Birmingham, Ala.
Cincinnati, Ohio.
Chicago, Ill.
Mackinac Island.
Old Point Comfort, Va.
Lake George, N. Y.
Philadelphia, Pa.
Richmond, Va.
Hot Springs, Va.
Spokane, Wash.

"The following places received 1 suggestion each:

Asbury Park, N. J.
Berkeley, Cal.
Boise, Idaho.
Buffalo, N. Y.
Bermuda.
Chattanooga, Tenn.
Charlotte, N. C.
Columbus, Ohio.
Cooperstown, N. Y.
Detroit, Mich.
Galveston, Tex.
Martha's Vineyard.
Memphis, Tenn.
Nashville, Tenn.
New London, Conn.
Honolulu, Hawaii.
Norfolk, Va.
Rochester, N. Y.
Samoset Hotel, Rockland, Me.
Saranac Lake, N. Y.
Thousand Island Park.
Western Europe.
St. Augustine, Fla.
Canada.
Lake Placid, N. Y.
"Dixie."
Some Canadian Summer Resort.
Any Place outside of the great Cities.
San Juan, Porto Rico.
Winnipeg, Man.
Some Pacific Coast City.

"As to the time for holding the Convention, 340 suggestions have been received, as follows:

January	1	July	45
February	5	August	9
March	9	September	6
April	10	October	3
May	22	November	4
June	183		

December or January	1	July or August	2
January or February	1	August or September	2
February or March	4	April or October	1
March or April	3	July, Aug., or Sept	1
April or May	2	After July 1st	1
May or June	2	June or September	1
June or July	5		

Spring	4	Mid-winter	1
Early Summer	1	Suitable Season	3
"Good old Summer time"	3	Usual time	2
Spring or Fall	1	Any part of year	1
Dry Season	1		

"All of which is respectfully submitted.

"CHAS. WARREN HUNT,
"Secretary."

"NEW YORK, JUNE 16TH, 1910."

MR. OCKERSON.—Mr. Chairman, I move that the time and place of the next Convention be referred to the Board of Direction, with power to act.

Discussion on Convention of 1911.

(The motion was seconded.)

MR. WHINERY.—Mr. President, I move to amend by adding to that resolution the recommendation that, in the sense of the Society, some summer resort, other things being equal, is considered preferable to a Convention in one of the large cities.

THE SECRETARY.—May I interrupt to say that I have a lot of correspondence here, both by letter and by wire, advocating the holding of the convention in various places, Little Rock, Ark., Jacksonville, Fla., Saratoga, N. Y., and so on.

W. F. REICHARDT, ASSOC. M. AM. SOC. C. E.—Mr. President, there is a letter there from the Governor of Arkansas, inviting us to meet in that State. I would like to have that read. The people of that State are very anxious to have this Society visit Arkansas.

(The Secretary then read the following letter:)

"JUNE 17TH, 1910.

"THE AMERICAN SOCIETY OF CIVIL ENGINEERS,
"Chicago, Ill.

"GENTLEMEN: I most heartily join in the invitation for you to hold your 1911 National Convention in the City of Little Rock, Arkansas.

Discussion on Convention of 1911 (continued).

I understand that the people of the South have never had the honor of having your Convention held in their midst, and we would love to entertain you and have you partake of our hospitality. Not only the people of Little Rock, but the people of the entire State would feel honored to have you meet here, and should you decide to do so, I can assure you of a most cordial welcome at the hands of everyone.

"I trust that you may decide to hold your 1911 Convention at Little Rock.

"Very respectfully,
"G. W. Donaghey,
"Governor."

The Secretary.—Invitations to hold the convention in Little Rock have also been received from the Mayor, the Board of Trade, the Country Club, and from Messrs. Ford, Kieser, and MacCrea.

Invitations to visit Jacksonville, Fla., have been received from the following members of the Society residing in Florida, provided the Convention could be held in the spring or fall: Messrs. J. W. Sackett, J. M. Braxton, A. F. Harley, M. A. Waldo, E. B. Thomson, F. O. Maxson, G. Rommel, Jr., F. W. Bruce, W. H. Caldwell, B. Thompson, W. A. Hunicke, F. C. Phillips, P. L. Wilson, G. R. Heckle, W. W. Fineren, and H. I. Snyder. The Mayor and the Board of Trade have also sent invitations, and Mr. H. M. Flagler, of the Florida East Coast Railway, has offered free transportation over his road from Jacksonville to Key West and return.

Invitations to hold the Convention in Seattle, Wash., have been received from members of the Society resident in that city, from the Seattle Board of Trade, and from the Pacific Northwest Society of Engineers. Invitations have also been received from Saratoga Springs, N. Y.

A Member. I am in receipt of a wire requesting me to supplement the invitation from Jacksonville with a few words, to urge upon the Society the selection of Jacksonville. I think that April has been suggested as the time, but the climate is very good during any part of the early spring. The accommodations would also be entirely sufficient. Jacksonville is second to no other city in the South, as far as hotel accommodations are concerned. The engineering work going on in Florida at the present time is also extensive—the St. John's River and the Everglades drainage—and I think that, inasmuch as that part of the South has never had a meeting of the American Society of Civil Engineers, it would be very proper for us to go there.

W. L. Saunders, M. Am. Soc. C. E.—Mr. Chairman, I am very much in favor of leaving this question to the decision of the Board of Direction. At the same time, it seems to me that the Board of Direction would naturally ask this meeting, which is a very large one, to express its views so that they can decide the question intelligently in the interests of the Society. Now, the question in my mind is not so much who wants us to go somewhere, and how accommodating the people will be who want us to go to this place or that locality, as it is what is the best in the interests of all and of profit to the American Society of Civil Engineers, and, with that thought in view, I am personally very much in favor of this Society going to the Isthmus of Panama. Now, that suggestion will not please the correspondent who wrote to the Secretary that he wanted to hold the meeting in the "good old summer time." The work on the Isthmus of Panama is the most important piece of work—with apologies to the President for that work in New York over which he presides—but on the Isthmus of Panama they are now engaged in a piece of engineering which is not only profitable for this Society to visit, but even the members of the American Institute of Mining Engineers, having less interest, have already decided to take the trip. They are going about November next, 300 strong, not only because it is a pleasant trip, but because they desire an opportunity of understanding this tremendous work, there having been some criticism of it in some of the papers read before the Institute. It seems to me eminently fitting that this Society, as a representative civil engineering body, should go down there now, right in the midst of that great civil engineering work. (Applause.)

The President.—Are you ready for the question? The vote will be taken first on the amendment proposed by Mr. Whinery. The amendment is that, while the matter be referred to the Board of Direction, it is the sense of this meeting that the Convention be held in some summer resort, other things being equal, preferably to holding it in a large city.

(On being put to a *viva voce* vote, the amendment was lost.)

The President.—We will now take a vote on the original motion.

Mr. Saunders.—Will you please repeat the original motion?

The President.—The original motion is that the matter of selecting the time and place for the next Annual Convention of the American Society of Civil Engineers be referred to the Board of Direction with power to act.

(The motion was carried unanimously.)

The President.—The next matter on the programme is the report of the Committee on Rail Sections.

The Secretary.—Mr. President, the following report has been received, addressed to the Society:

REPORT OF SPECIAL COMMITTEE ON RAIL SECTIONS

Report of Special Committee on Rail Sections.

To the American Society of Civil Engineers:

Gentlemen:

Your Special Committee on Steel Rails, since their appointment in 1902, have held numerous meetings, not only of their own body, but

Report of Committee on Rail Sections (continued).

also in conference with Committees representing other Societies and the steel rail makers. The results of their deliberations have been presented to the Society in their reports presented on—

January 21st, 1903
" 18th, 1905
" 17th, 1906
" 16th, 1907
July 9th, 1907
December 6th, 1907
" 18th, 1908
November 30th, 1909

As previously reported to you, the Rail Committee of the American Railway Engineering and Maintenance of Way Association is also acting for the American Railway Association; and the latter organization has guaranteed to it the necessary funds to make exhaustive tests and observations as to the wear, breakage, etc., etc., of steel rails. This work is being prosecuted, and will of necessity require several years.

Your Committee feels that it has nothing to add to the several reports which it has presented to the Society, particularly as, so far, the several cardinal principles outlined in them are being practically followed in the several used and proposed specifications and rail sections.

In view of the foregoing, your Committee would respectfully ask to be discharged so that the field may be clear if at any future time the Society should desire to again place the subject in the hands of a Committee.

JOSEPH T. RICHARDS,
C. W. BUCHHOLZ,
E. C. CARTER,
S. M. FELTON,
ROBERT W. HUNT,
JOHN D. ISAACS,
RICHARD MONTFORT,
H. G. PROUT,
PERCIVAL ROBERTS, JR.,
GEORGE E. THACKRAY,
EDMUND K. TURNER,

Approved in connection with the attached report:

WILLIAM R. WEBSTER.

JUNE, 1910.

PHILADELPHIA, JUNE 1ST, 1910.

I have signed the Report of the A. S. C. E. Rail Committee,—"Approved in connection with the attached report," as I feel that the report is too condensed, and assumes that all are familiar with the Rail situation, especially what has been done by the other Societies.

The work undertaken by this Committee has been delegated by The American Railway Association to the Rail Committee of The American Railway Engineering and Maintenance of Way Association, and it therefore seems appropriate to give the results of their work, up to date, to our members in convenient form for reference, especially as our rail specifications have not been worked to, and they have offered a better specification that will be worked to, and no doubt largely used by the members of this Society. The specification is attached to this report.

In presenting this specification to the Annual Meeting at Chicago in March last, the Committee said:*

"A new specification should not be proposed at this time without careful consideration. So far as we know, no railroad company has purchased rails under the specifications approved by the American Railway Association and referred to us; nor do we know of any railway company that has succeeded in buying rails during the past two years according to a specification entirely satisfactory to the railroad company. We believe that all of the specifications under which rails have been rolled have been compromises on the part of both parties, with the general result that neither party is entirely satisfied. Our experience during the year has brought to our attention some defects in all of the specifications now before us, and acting under the impression that there is a distinct feeling that we should revise our specifications, we offer the attached specifications for your consideration. Our Association has no specification for Open-Hearth Steel Rails, and in order to comply with the instructions, a specification for Open-Hearth Steel Rails is included.

"We believe it necessary to submit a sliding scale for the percentages of carbon and phosphorus, which provides for increasing the carbon as the phosphorus decreases. The fixing of this scale properly is a matter requiring care, and we admit that our knowledge on the subject is limited. The American Railway Association specification calls attention to this matter in the following words: 'When lower phosphorus can be secured, a proper proportionate increase in carbon should be made.' The amount of increase is not provided for in the specifications, and this appears to us to be necessary in order to secure uniformity of practice; otherwise, the fixing of these percentages becomes a matter of special arrangement. Bessemer rails are being furnished regularly with phosphorus under the maximum allowed, and where this is done, the carbon should be raised above the higher limit now fixed in our specifications, or a soft and poor wearing rail will result; yet this condition has not been fully guarded against in rails furnished under existing specifications. The lower and upper limits for carbon have heretofore been fixed with the intention that the mills furnish rails with a composition as near between the two limits as possible. The mills, however, in order to meet the prescribed drop tests with the least difficulty, keep both the carbon and manganese as

---

* *Bulletin No. 118*, December, 1909.

Report of Committee on Rail Sections (continued).

nearly as possible to the lower limits, with the corresponding result that a generally poor-wearing rail is furnished.

"Some roads have prescribed the limits of deflection to be allowed under the drop test. With our present knowledge, we believe that we should fix a minimum deflection to eliminate brittle rails and to secure greater uniformity of product; also maximum deflection to eliminate soft rails. We are not able at the present time to fix these limits, but our ultimate object will be to determine and fix such limits for the specifications.

"With reference to the amount of discard, time of holding in ladle, size of nozzles, and other such details of manufacture or machinery, we are of the opinion that the physical and chemical tests required should be prescribed, and that we should see that the material submitted for acceptance meets the prescribed tests. We should not dictate to the manufacturers the amount of crop which shall be removed from the top of the ingot, as this should vary with the care and time consumed at the various mills. The railroads should not be asked to take anything but sound material in their rails. The mills can furnish such sound material if the proper care and sufficient time are taken in the making of the ingots. Information derived from the tests being made at the Watertown Arsenal shows definitely that sound rails cannot be made from unsound ingots, and that, therefore, the prime requisite in securing a sound rail is to first secure the sound ingot.

"We recommend that the present Specifications for Steel Rails be withdrawn from the Manual of Recommended Practice of the Association, as no longer representing the current state of the art.

"We submit herewith, as Appendix 'A,' a form for specifications. It will have to be amended from time to time as we receive further information on the subject."

The specifications referred to above were modified and presented at the Meeting in *Supplement to Bulletin No. 121,* of March, 1910, and in this final form are attached hereto.

These specifications do not represent the work of any one Society or the work of any one Committee, but are the result of all the work of the different Societies, as the members of all are so interwoven that whatever work is done in any one Society, or by the Committee of a Society, has very naturally and fortunately been carried into the others.

At the Chicago Meeting these specifications were accepted without a single change, and this is very unusual and shows how generally acceptable they were, as the members of all Rail Committees were present at the Meeting. The main points in this specification were discussed and agreed upon by the members of the Committee and the Rail Committee of the manufacturers who have co-operated with them in this work.

In the matter of Rail Sections, the Rail Committee of The

American Railway Engineering and Maintenance of Way Association has not arrived at any definite conclusions. The new sections "A" and "B" of The American Railway Association have not given as good results as was expected of them, and the whole matter is yet under consideration. The Committee reported as follows:*

"The instructions of the American Railway Association require us to study the A. R. A. sections 'A' and 'B' in use and submit a single type for standard. Owing to the conditions existing in 1908, very little rail was laid, and practically none of the A. R. A. sections, in such manner as to give the needed information. This year, several roads have laid A. R. A. sections of rail, with a view of determining the relative merits of the respective sections. These rails have been in the track so short a time that we are not justified in drawing any conclusions as to which of the A. R. A. types, 'A' or 'B,' or if either, is better than the A. S. C. E. sections.

"*Bulletin No. 116,* issued October, 1909, gives the statistics for rail failures for six months from October 31, 1908, to April 30, 1909, as reported to the Committee. These statistics do show that the difference in section can be entirely annihilated by difference in chemical composition and by the treatment in furnace and mill.

"The results so far obtained from the heavy base A. R. A. sections are disappointing, as we have received some rail from the mills of the new section which was as bad as we did with the old A. S. C. E. section, showing that the quality of the rail does not depend entirely upon the section.

"The tests to be inaugurated by the Committee, combined with the results of the tests at Watertown and the performance of the rail in the track, will give us valuable data to aid us in coming to a final conclusion."

A careful study of the results already obtained, on both Bessemer and open-hearth steel rails, indicates that the next necessary step will be the use of a much heavier rail, and I think the sooner this is admitted and trial lots of say 1 000 tons each of 110-lb., 120-lb. and 130-lb. rails rolled, of Bessemer and open-hearth steel, and put in service under the most severe conditions, the sooner we will get rid of the present difficulties with our rails.

WM. R. WEBSTER.

"SPECIFICATIONS FOR STEEL RAILS.†

"1. The entire process of manufacture shall be in accordance with the best current state of the art. Process of Manufacture.

"(*a*) Ingots shall be kept in a vertical position until ready to be rolled, or until the metal in the interior has had time to solidify.

"(*b*) Bled ingots shall not be used.

**Bulletin No. 118*, December, 1909.

†Reprinted from *Supplement to Bulletin No. 121* of the American Railway Engineering and Maintenance of Way Association (March, 1910).

Chemical Composition.

"2. The chemical composition of the steel from which the rails are rolled shall be within the following limits:

	BESSEMER.		OPEN-HEARTH	
	70 lbs. and over, but under 85 lbs.	85 to 100 lbs. inclusive.	70 lbs. and over, but under 85 lbs.	85 to 100 lbs. inclusive.
Carbon	0.40 to 0.50	0.45 to 0.55	0.53 to 0.66	0.63 to 0.76
Manganese	0.80 to 1.10	0.80 to 1.10	0.70 to 1.00	0.70 to 1.00
Silicon	0.07 to 0.20	0.07 to 0.20	0.07 to 0.20	0.07 to 0.20
Phosphorus not to exceed	0.10	0.10	0.04	0.04
Sulphur not to exceed	0.075	0.075	0.06	0.06

"3. When the average phosphorus content of the ingot metal used in the Bessemer Process at any mill is below 0.08 and in the Open-Hearth Process is below 0.03, the carbon shall be increased at the rate of 0.035 for each 0.01 that the phosphorus content of the ingot metal used averages below 0.08 for Bessemer steel, or 0.03 for Open-Hearth steel.

"The percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits.

Shearing

"4. The end of the bloom formed from the top of the ingot shall be sheared until the entire face shows sound metal.

"All metal from the top of the ingot, whether made from the bloom or the rail, is the top discard.

Shrinkage.

"5. The number of passes and speed of train shall be so regulated that, on leaving the rolls at the final pass, the temperature of the rails will not exceed that which requires a shrinkage allowance at the hot saws, for a 33-ft. rail of 100 lb. section, of 6½ in. for thick base sections and 6¾ in. for A. S. C. E. sections, and ⅛ in. less for each ten pounds decrease of section, these allowances to be decreased at the rate of 1-100 in. for each second of time elapsed between the rail leaving the finishing rolls and being sawed.

"The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling them be used between the leading and finishing passes, nor after they leave the finishing pass.

Section.

"6. The section of rail shall conform as accurately as possible to the templet furnished by the Railroad Company. A variation in height of 1-64 in. less or 1-32 in. greater than the specified height, and 1-16 in. in width of flange, will be permitted; but no variations shall be allowed in the dimensions affecting the fit of splice bars.

Weight.

"7. The weight of the rail shall be maintained as nearly as possible, after complying with the preceding paragraph, to that specified in the contract.

"A variation of one-half of one per cent. from the calculated weight of section, as applied to an entire order, will be allowed.

"Rails will be accepted and paid for according to actual weight.

Length.

"8. The standard length of rail shall be 33 ft.

"Ten per cent. of the entire order will be accepted in shorter lengths varying by 1 ft. from 32 ft. to 25 ft.

"A variation of ¼ in. from the specified lengths will be allowed.

"All No. 1 rails less than 33 ft. shall be painted green on both ends.

Finishing.

"9. Care shall be taken in hot-straightening rails, and it shall result in their being left in such condition that they will not vary throughout their entire length more than four (4) in. from a straight line in any direction for thick base sections, and 5 in. for A. S. C. E. sections when delivered to the cold-straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails and be so marked.

"The distance between supports of rails in the straightening press shall not be less than forty-two (42) in.; supports to have flat surfaces and out of wind. Rails shall be straight in line and surface and smooth on head when finished, final straightening being done while cold.

"They shall be sawed square at ends, variations to be not more than 1-32 in., and prior to shipment shall have the burr caused by the saw cutting removed and the ends made clean.

Drilling.

"10. Circular holes for joint bolts shall be drilled in accordance with specifications of the purchaser. They shall in every respect conform accurately to drawing and dimensions furnished and shall be free from burrs.

Branding.

"11. The name of the manufacturer, the weight of the rail, and the month and year of manufacture shall be rolled in raised letters and figures on the side of the web. The number of the heat and a letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail, where it will not be covered by the splice bars. Rails to be lettered consecutively A, B, C, etc., the rail from the top of the ingot being A. In case of a top discard of twenty or more per cent. the letter A will be omitted. Open-Hearth rails to be branded or stamped O. H. All marking of rails shall be done so effectively that the marks may be read as long as the rails are in service.

Drop Testing.

"12. (*a*) Drop tests shall be made on pieces of rail rolled from the top of the ingot, not less than four (4) ft. and not more than six (6) ft. long, from each heat of steel. These test pieces shall be cut from the rail bar next to either end of the top rail, as selected by the Inspector.

"The temperature of the test pieces shall be between forty (40) and one hundred (100) degrees Fahrenheit.

"The test pieces shall be placed head upward on solid supports, five (5) in. top radius, three (3) ft. between centers, and subjected to impact tests, the tup falling free from the following heights:

70 lb. rail	16 ft.
80, 85 and 90 lb. rail	18 ft.
100 lb. rail	20 ft.

"The test pieces which do not break under the first drop shall be nicked and tested to destruction.

"(*b*) (It is proposed to prescribe, under this paragraph, the requirements in regard to deflection, fixing maximum and minimum limits, as soon as proper deflection limits have been decided upon.)

Tests. "13. (A) Two pieces shall be tested from each heat of steel. If either of these test pieces breaks, a third piece shall be tested. If two of the test pieces break without showing physical defect, all rails of the heat will be rejected absolutely. If two of the test pieces do not break, all rails of the heat will be accepted as No. 1 or No. 2 classification, (according as the deflection is less or more, respectively, than the prescribed limit.*)

"(B) If, however, any test piece broken under test A shows physical defect, the top rail from each ingot of that heat shall be rejected.

"(C) Additional tests shall then be made of test pieces selected by the Inspector from the top end of any second rails of the same heat. If two out of three of these second test pieces break, the remainder of the rails of the heat will also be rejected. If two out of three of these second test pieces do not break, the remainder of the rails of the heat will be accepted, provided they conform to the other requirements of these specifications, as No. 1 or No. 2 classification, (according as the deflection is less or more, respectively, than the prescribed limit.*)

"(D) If any test piece, test A, does not break, but when nicked and tested to destruction shows interior defect, the top rails from each ingot of that heat shall be rejected.

Drop-Testing Machine. "14. The drop-testing machine shall be the standard of the American Railway Engineering and Maintenance of Way Association, and have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of five (5) in.

"The anvil block shall be adequately supported and shall weigh 20,000 lbs.

"The supports shall be a part of or firmly secured to the anvil.

No. 1 Rails. "15. No. 1 rails shall be free from injurious defects and flaws of all kinds.

No. 2 Rails. "16. Rails which, by reason of surface imperfections, are not accepted as No. 1 rails, will be classed as No. 2 rails, but rails containing physical defects which impair their strength, shall be rejected.

"No. 2 rails to the extent of five (5) per cent. of the whole order will be received. All rails accepted as No. 2 rails shall have the ends painted white, and shall have two prick punch marks on the side of the web near the heat number near the end of the rail, so placed as not to be covered by the splice bars.

"Rails improperly drilled, straightened, or from which the burrs have not been properly removed, shall be rejected, but may be accepted after being properly finished.

"Different classes of rails shall be kept separate in shipment.

"All rails shall be loaded in the presence of the inspector.

Inspection. "17. (*a*) Inspectors representing the purchaser shall have free entry to the works of the Manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the Manufacturer to satisfy them that the rails have been made in accordance with the terms of the specifications.

---

* Note: The clause in brackets in Sections A and C to be added to the specifications when the deflection limits are specified.

"(*b*) For Bessemer Steel the Manufacturer shall, before the rails are shipped, furnish the Inspector daily with carbon determinations for each heat, and two complete chemical analyses every twenty-four hours representing the average of the other elements specified in section 2 hereof contained in the steel, for each day and night turn respectively. These analyses shall be made on drillings taken from the ladle test ingot not less than ¼ in. beneath the surface.

"For Open-Hearth Steel, the makers shall furnish the Inspectors with a complete chemical analysis of the elements specified in section 2 hereof for each melt.

"(*c*) On request of the Inspector, the Manufacturer shall furnish drillings from the test ingot for check analysis.

"(*d*) All tests and inspections shall be made at the place of manufacture, prior to shipment, and shall be so conducted as not to unnecessarily interfere with the operation of the mill."

THE PRESIDENT.—You have heard the report of the Rail Committee, which is in effect a request to be discharged as a committee. The Chair would therefore be pleased to entertain a resolution to the effect that the Committee be discharged or be not discharged.

MR. OCKERSON.—Mr. President, I would like to have the reason for the discharge of the Committee read again.

(The Secretary read the last portion of the report of the Committee on Rail Sections again.)

MR. DABNEY.—Mr. Chairman, I think that the Committee is most competent to judge as to the propriety of its discharge. I move that the Committee be discharged as requested.

(The motion being duly seconded was carried unanimously.)

THE PRESIDENT.—The next business is the report of a committee appointed to formulate the general lines which should be followed in legislation affecting the practice of civil engineers.

(The Secretary read the report of the Committee, as follows:)

REPORT OF
COMMITTEE ON THE LICENSING OF CIVIL ENGINEERS

Report of Committee on the Licensing of Civil Engineers.

TO THE AMERICAN SOCIETY OF CIVIL ENGINEERS:

At a meeting of the Society, April 6th, 1910, the following resolution adopted by the Board of Direction was presented:

"*Resolved,* That it is the sense of the Board that it is the duty of the American Society of Civil Engineers to use its influence in the proper formulation of all legislation by the General Government, or by any of the States of the Union, which affects the practice of Engineers; and the Board recommends the appointment by the Society of a Committee whose duty it shall be to formulate the general lines on which such legislation should be based, and that said Committee be requested to report at the next Annual Convention."

The undersigned, appointed a Committee for the purposes set forth in the above resolution, beg leave to report as instructed.

Report of Committee on the Licensing of Civil Engineers (continued).

Your Committee issued a circular to the membership of the Society asking for information concerning laws which are now in force, or have been proposed, in the various States of the Union and in other countries.

While this circular did not ask for an expression of opinion from the membership as to the advisability of the enactment of laws relating to the practice of Engineering, 32 of the 70 Members who replied expressed themselves as decidedly in favor of such laws if properly drawn, and only 6 expressed opposition.

As far as the Committee has been able to ascertain, there are statutes of some kind in force, relating to the practice of Engineering, in Canada, Mexico, and in the States of Wyoming, Louisiana, and Florida. There are also statutes governing the practice of Land Surveyors in the States of Idaho and South Dakota.

Canada.—The Committee has been informed that the licensing of Engineers is in the hands of each Province. In the Province of Quebec the law requires that a practitioner of Engineering shall be a Corporate Member of the Canadian Society of Civil Engineers.

Mexico.—Engineers may practice anywhere in the Republic without a license, except in the City of Mexico, where a diploma from the National Engineering School is required.

Wyoming.—The law in this State covers the practice of Irrigation Engineering. There is a Board of Examiners, consisting of the State Engineer and two engineers "of thorough training and experience, appointed by the Governor," and serving without compensation. Fees collected go to defray the expenses of the Board. Certificates are issued to five classes of Engineers, as follows:

(1) Land Surveyor.
(2) Topographic Engineer. (Examination in plain and topographical surveying.)
(3) Hydraulic and Hydrographic Engineer. (Examination in surveying and hydraulics.)
(4) Construction and Designing Engineer. (Examination in surveying, design of irrigation works and structures, and computation of earth work.)
(5) Administrating Irrigation Engineer. (Examination in surveying, hydraulics, construction work, irrigation law and practice.)

This law is said to be an unqualified success, in that it has placed Irrigation Work on a higher plane, protecting, to a certain extent, those who are capable of good work, and in a great measure protecting the public.

Louisiana.—The law in this State was enacted in 1908, and makes it a misdemeanor, punishable by fine or imprisonment, or both, to practice Civil Engineering without a license. Engineers practicing at that time, were allowed to continue to practice by registering, before a certain date, at the Court House of their respective Parishes. After that date, all those not registered were required to demonstrate their fitness before a State Board of Examiners.

The following statement is briefed from the reply of a correspondent of the Committee: A majority did register, but many did not. Some passed the examination, some failed to pass, and some looked at the examination and did not try it. In this way some incompetent persons were gotten rid of by this law "simple as it is." Doubtless there are some who practice without a license, but no one has been reported to the Grand Jury for so doing. One of the Examining Board has stated that he would rather not antagonize these people until the public began to see the good effects of the law. While the law is intended to cover Engineers working for corporations, as well as those in private practice, corporation lawyers contend that it does not so apply, but this question has never been decided. The examinations cover both the practical and theoretical knowledge of the applicant, but are not made difficult. The following is a brief statement of the requirements of the law:

(1) A diploma from an Engineering College or School of good standing (said standing to be determined by the Board), or the passing of a satisfactory examination before the Board, upon the following:

"For Surveying: Geometry, Trigonometry, Land Surveying, and Practical Use of Instruments;"

"For Civil Engineering: Same as Surveying, and in addition thereto, Natural Philosophy or Physics."

(2) The practitioner must be 21 years old, of good moral character, and possess "at least a fair preliminary education."

Five members of the Board of Examiners are appointed by the Governor, from a list presented by the Louisiana Engineering Society. Members of the Board are paid $10 per day and expenses. The fees charged are $1 for the issue of a certificate, and $10 for each examination.

The law expressly states that its provisions "shall not apply to the Engineering Department of the United States, nor to the Civil Engineers and Surveyors of other States and Territories when in actual consultation with registered Civil Engineers or Surveyors of this State."

Florida.—In this State there is only one restriction, viz.: That anyone calling himself a Civil Engineer, and practicing as such, shall pay the State an annual privilege tax of $10.

In **Idaho** and **South Dakota,** as stated before, the law concerns only Land Surveyors, who must pass an examination before a Board of Examining Surveyors, file a bond of $500, and pay fees of $5 and $15, respectively.

The above covers the information in the hands of the Committee as far as existing laws are concerned, but it appears that the subject of the licensing of Engineers has been agitated in the following five States, in all of which legislative bills have been unsuccessfully introduced: **New York, Ohio, Pennsylvania, South Carolina,** and **Washington.**

Your Committee believes that there is an unmistakable tendency toward legislation regulating the practice of Civil Engineers, and that

Report of Committee on the Licensing of Civil Engineers (continued).

it is important that there should be uniformity in all States, at least in so far as the requirements for admission to practice are concerned.

It is believed also that the statutes enacted by any State on this subject should define the term "Civil Engineer" alike, and that the following is properly descriptive:

"A Civil Engineer, within the meaning of this Act, is one who practices any branch of the Profession of Engineering other than Military. Said Profession embraces the design and construction of public or private utilities, such as Railroads, Bridges, Highways, Roads, Canals, Harbors, River Improvements, Light Houses, Irrigation Works, Water Supplies, Sanitary Systems, and the Development, Transmission, and Application of Power, and includes all Industrial, Hydraulic, Municipal, Structural, Electrical, Mechanical, Mining and other works which require experience and the same technical knowledge as Engineering Schools of recognized reputation prescribe for graduation."

Your Committee further recommends that all such statutes should prescribe the following minimum requirements for a practitioner of Civil Engineering:

1.—That he shall be not less than 25 years of age.
2.—That he shall be of good moral character.
3.—That he shall have been engaged actively in Civil Engineering work, as an Assistant to a licensed practitioner, for at least six years, and as such shall have had responsible charge of engineering work for at least one year.
4.—For a graduate from a school of Engineering of recognized reputation, the term of actual engagement as an Assistant shall be four years.

The foregoing are the minimum requirements for Corporate Membership in the American Society of Civil Engineers, and, in the opinion of your Committee, there should also be inserted in any law a clause to the effect that the Certificate of Corporate Membership in this Society entitles its holder to practice as a Civil Engineer without examination.

All State laws should also be uniform in their provision for the necessary examination of candidates for admission to practice, and your Committee suggests that such examinations be conducted by a Board of five (5) Civil Engineers, appointed by the Governor of the State, and serving without compensation other than actual expenses, each of whom shall be not less than thirty (30) years of age, and shall have been in active practice for not less than ten (10) years. Said Board to conduct examinations not less than three times each year at different places in the State; to prepare all examination papers; rate each candidate and certify to said rating to the State Board of Regents, or other similar authoritative body. Said authoritative body shall thereupon issue to successful candidates licenses to practice as Civil Engineers. The Committee recommends that the fee for the issue of a certificate giving the right to practice shall not exceed the sum of $25.

Your Committee recommends that all laws shall prescribe that it shall be unlawful for anyone unlicensed to accept engagement as a Civil Engineer, and that no unlicensed person shall be allowed to sue in any court of the State for compensation for services rendered, or to qualify as an expert witness before any State or Municipal Court.

Your Committee deems it beyond its duties to go into detail in matters which would in any event be governed by conditions which are variable, but it is recommended that the license to practice in one State should be, if possible, made effective in other States, so that Civil Engineers who are licensed to practice in any State or Territory shall have the right to practice in any other State without examination.

If laws are passed in all States of the Union upon the basis above outlined, it does not appear that there can be any valid objection from properly qualified Civil Engineers, and it is the opinion of your Committee that the enactment of such laws would result in placing the Profession upon a better basis, and would, in some measure at least, protect the public from incompetent and irresponsible practitioners.

Your Committee recommends that the Board of Direction be empowered in behalf of the Society to take up this matter with the proper authorities from time to time as may be deemed expedient, and to urge the enactment of State laws governing the practice of Civil Engineers in general conformity with the suggestions of this report, and further, that the Board appoint from the membership of the Society a Committee of three (3) in each State to co-operate with the Board in this matter, and to act under its direction.

Respectfully submitted,

J. A. Bensel,
Wm. H. Burr,
James Owen,
Chas. Warren Hunt,
Committee.

New York,
June 14th, 1910.

Discussion on Licensing of Engineers.

G. S. Williams, M. Am. Soc. C. E.—Mr. Chairman, I move that the report of the Committee be accepted.

The President.—Is there any discussion on the subject, gentlemen?

Mr. Whinery.—Mr. President, this is a very large question, as we all appreciate. There could be no question, I presume, among the members of the profession but that some degree of regulation, at least, of the practice of civil engineering is desirable. The question, however, is surrounded by a great many very serious difficulties, which may be solved, but which will require a vast amount of time and con-

Discussion on Licensing of Engineers (continued).

sideration, and conferences with members of other branches of engineering, before anything can be done. I do not know that this recommendation carries with it any authoritative action of the Society, further than the appointment of this Committee, and to that extent I heartily commend the report and am in favor of it. It seems to me, however, that the disposition that has been shown in some branches of the Society or by some members of the profession to deal hastily with this question is all wrong; and, if it is gone into at all, it must be thoroughly investigated, and any proposed legislation very carefully considered and very carefully planned.

For instance, on one point here, which is all right, the report given by the Committee covers all branches of engineering as we understand it. Now, the Committee recommends that corporate membership in the American Society of Civil Engineers shall entitle the holders thereof to licenses. What about our brothers in the mechanical engineering and electrical engineering branches, and so on? There are a great many difficulties in this question, and I might say that I had the honor of serving on a committee a few years ago, and it was the sense of that committee that the difficulties which surround any State legislation of this kind which may be satisfactory or effective, are so great that it is very questionable whether anything of real value, anything that will be really acceptable to the profession of engineering, can be devised which will cover the point satisfactorily, because, as the Committee report says, whatever action is passed must apply to other branches of engineering as well as civil engineering.

Then, there is another matter: Here is a society asking that the State shall step in and regulate the practice of civil engineering. Now, in place of that, this Society has repeatedly refused to take up the consideration of preparing and adopting a code of ethics which shall express the views of our own Society with reference to the very many matters which must be dealt with in a law like this. Now, it would seem to me eminently appropriate that this Society should first adopt some code of ethics, some rules regulating the practices of the profession, and of its own members, before asking the State to interfere in behalf of its members.

W. B. Storey, Jr., M. Am. Soc. C. E.—Mr. Chairman, I wish to bring forward the difficulty that will come into the practice of handling a matter of this kind by the various States having different laws. Any recommendations that we might make will simply indicate that we are in favor of laws passed by the State, and yet the laws of one State may differ entirely from those of another. Many of our large corporations have forces of engineers that go from one part of the country to another, and it would entail a great deal of trouble and difficulty to have them licensed in all States, and it introduces a subject and a point which I think will hamper rather than help the profession in any way.

Another point occurs to me, while we are discussing the question: A number of years ago California introduced a law which licensed surveyors, and the motive was largely done in the way of trade unionism, rather than to help the profession. It was not a method on the part of the people of protecting engineers, but was drawn with a view of elevating the position of engineering, and making the engineer's services more valuable. The matter eventually became a dead letter. In fact, a great deal of work was done, the law was not complied with, and, there being no sentiment among the people demanding that the law be enforced, it has become a dead issue.

George G. Anderson, M. Am. Soc. C. E.—The Colorado members of this Society considered this matter for some time before the parent Society took it up. We have at various times made progress reports on this matter to the Society, and it is pleasing to find that our deliberations in Colorado have met with the approval of, and perhaps anticipated very largely the fundamental ideas which have been submitted by, the Committee of the Board of Direction in this report. However, we find that an emergency exists. We know that if the Society does not introduce some bill before the coming Legislature, a bill will be introduced, and we feel that it may contain very radical ideas which will be very difficult to control and regulate there afterward. The members of the local association in Colorado feel that it is their duty to take initial steps in this matter. We feel that it should be done as soon as possible, and as nearly as possible in a uniform line in harmony with what the parent Society may do throughout the United States generally. We feel that examinations and licenses in one State should give the right to practice in all States, as far as possible. We believe in the idea of a uniform system of laws, as far as it is possible to carry it out; and that it is preferable at this time, seeing that the ground is very largely a virgin one; and we feel that we ought to make the endeavor, through the agency of this Society, for nearly uniform, if not entirely uniform, legislation on this subject. On the question of examinations, there may be, and undoubtedly will be, a very large difference of opinion. As near as we can ascertain at this time, the Society has about 90 members in Colorado; while there are between 300 and 400 practicing engineers. We cannot very well rope them in to become members of this Society, and to come in under the classification of corporate membership. However, we will endeavor to do so as fast as it is possible, and, as far as it is possible, without creating friction and without creating resentment against the possibility of the passage of such an enactment.

As far as the question of examination is concerned, I think a very large number of the members in Colorado who have been approached upon this subject, in the spirit in which Mr. Whinery has referred to the matter, find it very difficult to solve; but we find that very many

Discussion on Licensing of Engineers (continued).

of the members are in favor of a technical examination, and I want to point out that the Wyoming law, which has been in effect for about a year, gives the Board of Examining Engineers the discretion of conducting a technical examination or of investigating the record of the applicant, and I understand that in only one case in the year in which that law has been in operation in Wyoming has an examination been waived; that in all cases it has been insisted upon, and apparently with good results. If the Society, then, believes this to be the proper course, within the next two or three months it should draft a bill and submit it to the Board of Direction for approval, and it might be a very good suggestion that, since we are somewhat radical in our ideas in Colorado, the proposition might be "tried on the dog." We can pass all sorts of freak legislation, but we do not consider this freak legislation, and we do feel that, unless the members of the Society send up for passage a good measure, some freak legislation on this question will be enacted by our State.

C. M. STRAHAN, ASSOC. M. AM. SOC. C. E.—Mr. Chairman, all recognize the difficulty of carrying into effect any such idea as promulgated in this valuable report, and we also recognize the many difficulties that lie in its way, but I do not feel that it is a hopeless task, in view of what our legal brethren have done, and our medical brethren. It looks to me as though in course of time we could get some sort of basis which would gradually work itself out into a fairly uniform practice in the several States.

While I feel that way, I rise principally to make this suggestion, that those of us who, like myself, live at some distance from the hubs of engineering activity find that while a membership in this Society is a real and powerful force toward giving standing in the engineering profession, it does not do all that we want it to do, though it does have a powerful effect. Therefore, I feel that without waiting for general legislation, we can emphasize the importance and permanence of requirement for membership in this Society, and can emphasize the influence the Society exerts in a general way. By emphasizing I mean that it would be a wise thing if some kind of a diploma or certificate should accompany these corporate memberships. It is true, you can say, that by the time a man has joined this Society he has made some headway and is known to some extent, but I believe that any man in first joining the Society would appreciate that testimonial as a matter of record. It occurs to me, therefore, that after members have been admitted it would be very proper to charge a fee for membership, so that at that time a definite extract of the record upon which he was admitted could be made known to the public, in the paper of the home of the Society, and in some permanent paper where the man is practicing.

I suggest those things. Of course, they are not strictly germane to the question before us, but I have found that in Georgia the weight of the Society's name is very great, and I would like to see that weight increased in the furtherance of wise legislation in defining before the law some standard of civil engineering.

I am in favor of the adoption of the report because it recognizes a condition which has arisen in the country, and I believe it is true that this Society should have a voice in establishing this sort of legislation. If we are going to have this legislation, I think we should have a voice in shaping it. I do not know that it is a recommendation of this Society so much, or that it will be the act of this Society, in case it adopts this report, to advocate this resolution, as to place this Society where it will enter into this work and have a part in the shaping of the result.

Mr. Dabney.—Mr. Chairman, if it is in order, I would like to offer an amendment to the resolution now before the house, that the committee be instructed to seek the co-operation of other engineering societies which are to be covered, as I understand it, by the legislation proposed by this Society.

The President.—Mr. Dabney, personally, I hope that such an amendment will not be passed, because this Society cannot act for any other body. You have had your attention called to the fact by Mr. Whinery that we do not take that position in any matter. The doors of the Society are open to all comers practicing in civil engineering.

Mr. Dabney.—I withdraw the amendment.

Mr. Ockerson.—Mr. Chairman, I have confidence enough in the Board of Direction to leave the matter in its hands. I do not think that it will go to extremes. I think the report should be approved by the Society.

Mr. Whinery.—What is the purpose of this committee of three from each State? What is that for? Does it mean that that is simply an advisory committee?

The President.—I suppose that any legislation to be taken up in any State would of necessity have to be taken up by a resident of that State, and therefore, to be properly presented before any legislative body, it would be necessary to take it up before that State by a resident; therefore the Board, acting through three members in a State, would probably work better. That, I take it, is the explanation of that recommendation.

(The motion being put to a *viva voce* vote was carried unanimously.)

The Chairman of the Local Committee on Arrangements announced the programme of the different excursions and pleasure trips.

The President.—There being no further business, the Business Meeting stands adjourned.

FORTY-SECOND ANNUAL CONVENTION

EXCURSIONS AND ENTERTAINMENTS

The arrangements for the Convention were in the hands of the following Committees:

Committee of Arrangements of the Board of Direction

Francis Lee Stuart,
William M. Gardner, Chas. Warren Hunt.

Local Committee

C. F. Loweth, *Chairman;*
W. E. Angier,
Charles B. Ball,
E. C. Carter,
C. H. Cartlidge,
F. R. Coates,
Horace E. Horton,
E. N. Layfield,
William B. Storey, Jr.,
C. L. Strobel,
O. J. West,
Paul Willis.

Informal Reception

Monday, June 20th, 1910.—8.30 p. m.—An informal reception, which was quite largely attended, was held in the Gold Room of the Congress Hotel, and provided a means for the visiting members and guests to become acquainted with the Chicago membership and with each other.

Automobile Drive through Parks

Tuesday, June 21st.—1.45 p. m.—As guests of the Chicago members of the Society, the members and guests were driven in automobiles through part of the park system of the City of Chicago, the route covering about 45 miles. The party, numbering about 300, started from the Congress Hotel at 1.45 p. m., and returned about three hours later.

Excursion to Gary, Indiana

Wednesday, June 22d.—The party, numbering about 300, embarked at the foot of Clark Street, at 10.00 a. m. on the steamship *United States*. Luncheon was served, and the landing was made at Gary, where the new Steel Plant of the United States Steel Corporation was inspected from a train of cars. Many of the party who were interested in the municipal features of this new city also had an opportunity to inspect the Water-Works, Sewerage, etc. The return to Chicago was made by steamer.

Other Excursions

Thursday, June 23d.—Four trips were arranged for this day.

1. Passing through a portion of the South Branch of the Chicago River into the Drainage Canal to Lockport, where the large bear-trap

dam, which has a crest 160 ft. long and a vertical oscillation of 17 ft.; a lock 130 by 22 ft., with a 40-ft. lift; a butterfly dam of unique construction, 160 ft. in length, and a water-power development of 40 000 h.p., were inspected. The return to the city was made by train.

2.—A party visited the $20 000 000 passenger terminal station of the Chicago and Northwestern Railway, now under construction.

3.—From the Chicago Yacht Club, at 10.00 A. M., a large party was taken by boat up the river to the Fisk Street power-station of the Commonwealth Edison Company, where this large and modern electric power-station, of 100 000 kw. or 133 000 h.p. capacity, was inspected.

4.—The members of the two latter parties and others, met at the Sears-Roebuck plant, where that firm provided a delightful luncheon, after which the buildings and equipment, and methods of conducting the largest mail-order house in the world, were inspected. The party returned to the Congress Hotel, reaching there about 4 P. M.

Excursion to Fort Sheridan, etc.

Friday, June 24th.—The last day of the Convention was devoted to an all-day excursion, which was attended by about 160 members and guests. By the courtesy of the Chicago and Northwestern Railway, a special train took the party from the Wells Street Station to Fort Sheridan, Lake Bluff, and Ravinia, passing through the beautiful north shore suburbs of Evanston, Glencoe, Winnetka, and Lake Forest. At Fort Sheridan, through the courtesy of Colonel William L. Pitcher, U. S. A., the party was entertained by drills and maneuvers of the troops, and inspected the buildings and grounds.

Leaving Fort Sheridan, luncheon was served on the train while it was moved to Lake Bluff, where the party was received by Admiral A. Ross, U. S. N., under whose guidance, the United States Naval Training Station at this point, which is under construction and nearly completed, was inspected.

Leaving Lake Bluff at 4.30 P. M., the party arrived at Ravinia Park and spent the remainder of the day and evening at this resort, music being furnished out of doors by a large orchestra, and dinner was served to the entire party under the trees. The return to the city was made at 10.30 P. M.

Golf

A number of members of the Society interested in golf, enjoyed a half-day tournament with the Chicago Engineers' Golf Club on the afternoon of Tuesday, June 21st, at the Skokie Country Club, Glencoe, Ill.; and on the afternoon of Friday, June 24th, a special half-day tournament was played at the Onwentsia Club, near Lake Forest, Ill., those who participated joining the party later at Ravinia Park for dinner.

Attendance

The following 315 members were in attendance. There were also present 234 ladies and others of the families of members.

Abbot, F. W.....New York City
Alderman, C. A..Buffalo, N. Y.
Alderson, W. H....Chicago, Ill.
Allen, Andrews....Chicago, Ill.
Allen, Henry C..Syracuse, N. Y.
Alvord, John W....Chicago, Ill.
Anderson, G. G...Denver, Colo.
Angier, W. E......Chicago, Ill.
Arentz, F. C. H......Joliet, Ill.
Armstrong, W. C..Chicago, Ill.
Arn, W. G.......Louisville, Ky.
Artingstall, S. G...Chicago, Ill.
Atwood, W. G.Indianapolis, Ind.

Babcock, W. S..New York City
Bake, W. S., Grand Rapids, Mich.
Baker, Ira O....Champaign, Ill.
Baldwin, A. S.....Chicago, Ill.
Ball, Charles B....Chicago, Ill.
Barber, W. D......Chicago, Ill.
Barnett, J. W......Athens, Ga.
Bates, Onward.....Chicago, Ill.
Beckwith, Frank.St. Paul, Minn.
Belcher, W. E.....Chicago, Ill.
Bell, G. J.......Marceline, Mo.
Bensel, J. A....New York City
Benzenberg, G. H., Milwaukee, Wis.
Berry, Claude.....Thomson, Ill.
Billin, C. E........Chicago, Ill.
Blaylock, J. C......Chicago, Ill.
Borland, Bruce.....Chicago, Ill.
Boucher, William J.Chicago, Ill.
Boyd, W. C......Pittsburg, Pa.
Breckinridge, W. L.Chicago, Ill.
Breithaupt, W. H., Berlin, Ont., Canada
Bremner, G. H.....Chicago, Ill.
Brenneke, W. G..St. Louis, Mo.
Brumley, D. J......Chicago, Ill.
Brunner, John.....Chicago, Ill.
Buehler, Walter..St. Louis, Mo.
Burdick, C. B......Chicago, Ill.
Burley, H. B...Brookline, Mass.
Burns, C. S..Kansas City, Mo.
Burt, H. J......Denver, Colo.

Cahill, J. E........Chicago, Ill.
Cahill, W. J.......Chicago, Ill.
Campbell, J. L....El Paso, Tex.
Cappelen, F. W., Minneapolis, Minn.
Carter, E. C.......Chicago, Ill.
Cartlidge, C. H....Chicago, Ill.
Chadbourn, W. H., Jr., St. Paul, Minn.
Chandler, E. F., University, N. Dak.
Chappell, C. E., Benton Harbor, Mich.
Clayton, T. W......Chicago, Ill.
Coates, F. R.......Chicago, Ill.
Cole, John A......Chicago, Ill.
Collar, W. F......Gwinn, Mich.
Condron, T. L.....Chicago, Ill.
Connor, E. H., Leavenworth, Kans.
Conrad, L. E..Manhattan, Kans.
Conzelman, J. E..St. Louis, Mo.
Cother, A. A......Chicago, Ill.
Cowles, W. L......Chicago, Ill.
Cowper, J. W......Chicago, Ill.
Crandall, C. L....Ithaca, N. Y.
Crocker, H. S....Denver, Colo.
Cunningham, A. O., St. Louis, Mo.
Curtis, W. W......Chicago, Ill.

Dabney, A. L..Clarksdale, Miss.
Dabney, T. G..Clarksdale, Miss.
Dart, C. R........Chicago, Ill.
DeBerard, W. W..Chicago, Ill.
Dencer, F. W......Chicago, Ill.

Denise, C. M......Chicago, Ill.
De Young, Isaac, Sault Ste. Marie, Mich.
Doyle, H. S.......Chicago, Ill.
Dufour, F. O......Urbana, Ill.

Eddy, Harrison P..Boston, Mass.
Eitzen, A. R......Chicago, Ill.
Espenshade, E. B...Chicago, Ill.
Ewing, W. B......Chicago, Ill.

Fanning, J. T., Minneapolis, Minn.
Fay, Frederic H..Boston, Mass.
Fenkell, G. H....Detroit, Mich.
Fickes, C. R.......Chicago, Ill.
Finley, W. H......Chicago, Ill.
Fisher, S. B......St. Louis, Mo.
Fitch, H. A...Kansas City, Mo.
Fitzpatrick, J. R., Grand Rapids, Mich.
Fox, J. A.....Cincinnati, Ohio
Francis, C....Davenport, Iowa
Fucik, E. J........Chicago, Ill.
Fuller, A. H....Seattle, Wash.
Fuller, G. W....New York City

Gardiner, F. W..New York City
Gaut, R. E.......Chicago, Ill.
Gerber, Emil.....Pittsburg, Pa.
Giddings, F....Atchison, Kans.
Gifford, R. L.......Chicago, Ill.
Godfrey, Edward..Pittsburg, Pa.
Graves, W. F......Chicago, Ill.
Graves, W. J., Sault Ste. Marie, Mich.
Green, P. E.......Chicago, Ill.
Greiner, J. E....Baltimore, Md.
Grimm, H. E......Chicago, Ill.

Hadsall, H. H......Chicago, Ill.
Hadwen, T. L. D...Chicago, Ill.
Hale, R. A....Lawrence, Mass.
Hall, J. R.........Chicago, Ill.
Hammond, A. J., South Bend, Ind.
Hanna, J. V..Kansas City, Mo.
Harris, G. H........Joliet, Ill.
Hastings, F. A., Martins Ferry, Ohio
Hatch, J. N.......Chicago, Ill.
Hatt, W. K.....Lafayette, Ind.
Hayford, J. F....Evanston, Ill.
Hendricks, V. K..St. Louis, Mo.
Henes, Harry W...Chicago, Ill.
Hill, C. D........Chicago, Ill.
Hitchcock, F. C.New York City
Hittell, J. B......Chicago, Ill.
Hoag, S. W., Jr..New York City
Holdrege, H. A...Omaha, Nebr.
Horton, G. T......Chicago, Ill.
Horton, Horace E..Chicago, Ill.
Hotchkiss, L. J....Chicago, Ill.
Hughes, W. M.....Chicago, Ill.
Humphrey, R. L..Pittsburg, Pa.
Hunicke, W. A...St. Louis, Mo.
Hunt, Charles Warren, New York City
Hunter, L. L.......Chicago, Ill.
Hyde, A. L......Columbia, Mo.

Jackson, W. B....Chicago, Ill.
Jacob, T. N..East St. Louis, Ill.
Jacobson, A. L...Paris, France
Johnson, A. N...Springfield, Ill.
Johnson, Maro.....Chicago, Ill.
Jonah, F. G......St. Louis, Mo.
Judd, Frank R....Chicago, Ill.

Keller, Charles.Rock Island, Ill.
Keller, C. L.......Chicago, Ill.
Ketchum, M. S....Denver, Colo.
King, R. S........Dayton, Ohio
Koch, J. C........Chicago, Ill.
Koon, J. B........Chicago, Ill.
Koon, R. E....Kansas City, Mo.

Lake, E. N........Chicago, Ill.
Lambert, B. J..Iowa City, Iowa

Larson, C. M. . . . . . Chicago, Ill.
Lawlor, F. D. H., Burlington, Iowa
Lawrence, E. H. . . . Chicago, Ill.
Layfield, E. N. . . . . Chicago, Ill.
Lea, S. H. . . . . . Pierre, S. Dak.
Lee, E. H. . . . . Chicago, Ill.
Lee, J. L. . Mount Vernon, N. Y.
Leonard, C. M. . . . Chicago, Ill.
Lewis, A. S. . . . . Chicago, Ill.
Lichtner, W. O., Newton Highlands, Mass.
Lovell, W. D. Minneapolis, Minn.
Loweth, C. F. . . . . . Chicago, Ill.
Lowrie, H. C. . . . New York City
Ludlow, J. W. . . . . . Chicago, Ill.
Lydon, W. A. . . . . . Chicago, Ill.

McConnell, J. L. . . . Chicago, Ill.
McCullough, Ernest. Chicago, Ill.
McDaniel, A. B., Vermilion, S. Dak.
McDonnell, R. E., Kansas City, Mo.
McGrew, A. B. . . Pittsburg, Pa.
McKay, G. A. North Chicago, Ill.
McLure, N. R. . . . St. Louis, Mo.
Maitland, A., Jr., Kansas City, Mo.
Malcolm, C. W. . . . . Urbana, Ill.
Marr, W. W. . . . . . . Chicago, Ill.
Maury, D. H. . . . . Peoria, Ill.
Maxwell, D. H. . . . . Chicago, Ill.
Meem, J. C. . . . Brooklyn, N. Y.
Mensch, L. J. . . . . . Chicago, Ill.
Merriman, M. . New York City
Metcalf, Leonard. Boston, Mass.
Meyers, A. M. . . Merriam, Kans.
Middleton, R. J. . Evanston, Ill.
Miller, C. H. . . . . . St. Louis, Mo.
Modjeski, R. . . . . . . Chicago, Ill.
Monroe, R. . . . Rock Island, Ill.
Montfort, R. . . . . Louisville, Ky.
Moore, J. E. . . . . . . Chicago, Ill.
Moorshead, T. C. . . . . Alton, Ill.
Morse, H. S. . . . . Louisville, Ky.
Morse, W. P. West Newton, Mass.
Mott, W. E. . . . . . Pittsburg, Pa.
Murphy, J. E. . . . . . Chicago, Ill.
Murphy, R. L. East St. Louis. Ill.

Neeld, C. M. . . . . Pittsburg, Pa.
Neher, F. . . . . St. Louis, Mo.
Nethercut, E. S. . . . Chicago, Ill.
Newman, R. M. . Jackson, Mich.
Newton, A. W. . . . . . Chicago, Ill.
Newton, S. D. . Knoxville, Tenn.
Nichol, H. S. . . . Somerset, Pa.
Noble, Alfred. . . . New York City

Ockerson, J. A. . St. Louis, Mo.

Packard, R. G. . New York City
Packard, R. G, Jr., New York City
Paige, Jason. . . . . . . Chicago, Ill.
Pearl, James W. . . . Chicago, Ill.
Pegram, G. H. . . . New York City
Pence, W. D. . . . . Madison, Wis.
Pendleton, D. E. . . . Ennis, Tex.
Perkins, Edward T. Chicago, Ill.
Philbrook, L. E. . . . Chicago, Ill.
Plock, A. F. . . . . . Mayville, Wis.
Porter, H. F. . . . . . Chicago, Ill.
Powell, A. V. . . . . . Chicago, Ill.

Quilty, T. F. . . . . . . Chicago, Ill.
Quincy, C. F. . . . New York City

Randolph, Isham. . Chicago, Ill.
Randolph, R. I. . . . . Chicago, Ill.
Raster, Walter. . . . . Chicago, Ill.
Raymond, W. G. Iowa City, Iowa
Reichardt, W. F., Little Rock, Ark.
Reichmann, A. F. . . Chicago, Ill.
Ridgway, R. Poughkeepsie, N. Y.
Riggs, H. E. . . . . . . Toledo, Ohio
Riggs, M. J. . . . . . . Toledo, Ohio
Rights, Lewis D. New York City

Ripley, H. C. . Cincinnati, Ohio
Ritter, L. E. . . . . . . Chicago, Ill.
Roberts, S. S. . . . Louisville, Ky.
Robinson, A. F. . . . . Chicago, Ill.
Robinson, W. R. . . . Chicago, Ill.
Rockwell, S.. . . . Cleveland, Ohio
Rosencrans, W. H. . Chicago, Ill.
Rundlett, L. W. . St. Paul, Minn.
Russell, S. B. . . . . St. Louis, Mo.

Sabin, A. T. . . . . Chicago, Ill.
Sabin, L. C., Sault Ste. Marie, Mich.
Sampson, C. B. . Antonito, Colo.
Sando, W. J. . . Milwaukee, Wis.
Sauerman, H. B. . . . Chicago, Ill.
Saunders, W. L. . New York City
Schneider, C. C. Philadelphia, Pa.
Schobinger, G. . . . . . Chicago, Ill.
Schwitzer, J. E., Winnipeg, Man., Canada
Scott, Addison M., Charleston-Kanawha, W. Va.
Scribner, G. H., Jr. Chicago, Ill.
Seaman, H. B. . New York City
Senior, F. S. . Montgomery, N. Y.
Seyfert, E. E. . . . Pittsburg, Pa.
Shankland, E. C. . . Chicago, Ill.
Shankland, R. M. . . Chicago, Ill.
Shaw, E. L. . . . . Chicago, Ill.
Sheldon, C. S. . . Norwood, Ohio
Shelmire, R. W. Cleveland, Ohio
Shenehon, F. C., Minneapolis, Minn.
Sherrerd, J. M. . . . . Easton, Pa.
Sinks, Frank F. . . . Chicago, Ill.
Slifer, H. J. . . . . Chicago, Ill.
Smith, J. Waldo. New York City
Smith, R. C. . . . . Chicago, Ill.
Spielman, J. G. . . . . Chicago, Ill.
Stern, I. F. . . . . . . Chicago, Ill.
Stevens, H. E. . St. Paul, Minn.
Stewart, C. B. . . . . Madison, Wis.
Stewart, J. T. . . St. Paul, Minn.
Storey, W. B., Jr. . . Chicago, Ill.
Stout, H. H. . . . . . . Chicago, Ill.
Strachan, Joseph . Brooklyn, N. Y.
Strahan, C. M. . . . . . Athens, Ga.
Strehlow, O. E. . . . . Chicago, Ill.
Strobel, C. L. . . . . . Chicago, Ill.
Stuart, Francis Lee, New York City
Sutton, Frank . Washington, D. C.
Swensson, Emil. . . Pittsburg, Pa.

Talbot, A. N. . . . . . . Urbana, Ill.
Taylor, A. J. . Wilmington, Del.
Tebbetts, G. E. . . . . . Chicago, Ill.
Theodorson, W. A. . Chicago, Ill.
Tighe, James L. . Holyoke, Mass.
Tratman, E. E. R. . Chicago, Ill.
Trumbull, M. K. . . . Chicago, Ill.
Tunstall, W. P. . . . . Chicago, Ill.
Turner, LeBaron. . . . Geneva, Ill.
Turrill, S. M. . . . . . Chicago. Ill.

Van Pelt, S. . . . . Chicago, Ill.
Vent, F. G. . . . . . . Chicago, Ill.
von Unwerth, H., Kansas City, Mo.

Waddell, J. A. L., Kansas City, Mo.
Wadsworth, J. E. New York City
Wall, Edward E. . St. Louis, Mo.
Wallace, H. U. . . . . Chicago, Ill.
Walther, Edward. . . Chicago, Ill.
Warder, J. H. . . . . . Chicago, Ill.
Wentworth, C. C. . . Roanoke, Va.
Wenzell, A. J. . . . Detroit, Mich.
Wescott, J. V. . . . . . Chicago, Ill.
West, O. J. . . . . Chicago, Ill.
Whinery, S. . East Orange, N. J.
Whipple, G. C. . New York City
Whittemore, D. J., Milwaukee, Wis.
Wilkerson, T. J. . Pittsburg, Pa.
Williams, G. S. Ann Arbor, Mich.
Williams, L. D. Milwaukee, Wis.
Williamson, C. S. Pittsburg, Pa.

Williamson, F. R. . Chicago, Ill.
Willis, Paul....... Chicago, Ill.
Wilson, E. B....... Chicago, Ill.
Wilson, P. H. . Philadelphia, Pa.
Winsor, F. E. White Plains, N. Y.
Wisner, G. M...... Chicago, Ill.
Woermann, J. W. . St. Louis, Mo.
Wölfel, Paul L... Pittsburg, Pa.
Woodman, A. W.... Chicago, Ill.
Woods, H. D. West Newton, Mass.
Worcester, J. R... Boston, Mass.

Yappen, Adolph. . Oak Park, Ill.

Zook, M. A........ Chicago, Ill.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

September 7th, 1910.—8.30 P. M.—A paper entitled "Remedies for Landslides and Slips on the Kanawha and Michigan Railway," by R. P. Black, Assoc. M. Am. Soc. C. E., will be presented for discussion.

This paper was printed in *Proceedings* for May, 1910.

September 21st, 1910.—8.30 P. M.—The following papers on The New York Tunnel Extension of the Pennsylvania Railroad will be presented for discussion: "The Long Island Approaches to the East River Tunnels," by George C. Clarke, M. Am. Soc. C. E.; "The Sunnyside Yard," by Louis H. Barker, Esq.; and "The Lining of the Four Permanent Shafts of the East River Division," by F. M. Green, Assoc. M. Am. Soc. C. E.

These papers are printed in this number of *Proceedings*.

October 5th, 1910.—8.30 P. M.—At this meeting a paper entitled "The Tieton Canal," by E. G. Hopson, M. Am. Soc. C. E., will be presented for discussion.

This paper is printed in this number of *Proceedings*.

October 19th, 1910.—8.30 P. M.—A paper by W. F. Strouse, M. Am. Soc. C. E., entitled "The Reconstruction of the Passenger Terminals at Washington, D. C.," will be presented for discussion.

This paper is printed in this number of *Proceedings*.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendix* to the Annual Report of the Board of Direction for the year ending December 31st, 1906, contains a summary of all searches made to that date.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussion of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings*. The issue of volumes of *Transactions* is dependent on the closing of discussions, and the co-operation of the membership in this matter is essential to the regular issue of each quarterly volume.

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings*, and set down for presentation to a future meeting of the Society, and, on these, oral discussion, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions*.

SUBSCRIPTION PRICE TO THE PUBLICATIONS OF THE SOCIETY

The following subscription rates have been fixed by the Board of Direction for the publications of the Society:

Proceedings, ten Numbers per annum, $8. Price for single numbers, $1.

Transactions, four Volumes per annum, $12. Price for single volumes, $4.

On the above prices there is a discount of 25% to members who desire extra copies of any of these publications, to Libraries, and to Book-dealers.

---

* *Proceedings*, Vol. XXXIII, p. 20 (January, 1907).

There is also an additional charge per annum, to cover foreign postage, of 75 cents for *Proceedings* and $1 for *Transactions,* or 8 cents and 25 cents, respectively, for single numbers.

A special subscription rate has been fixed by the Board for the *Proceedings* of the Society for the benefit of Students in Technical Schools. This rate is $4.50 per annum, and is available to any *bona fide* student of any technical school.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Fairmont Hotel, on the third Friday of February, April, June, August, October, and November, and also on the third Wednesday of December, the latter being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., Assoc. M. Am. Soc. C. E., 623 Wells Fargo Building.

The by-laws of the Association provide for the extension of hospitality to any members of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest of the Association at any of the above meetings, if he will notify the Secretary that he is in San Francisco.

Colorado Association

(Abstract of Minutes of Meetings)

May 16th, 1910.—Instead of the May meeting of the Association, an excursion was made to the plant of The Central Colorado Power Company, near Boulder, Colo., by invitation of that Company through Frederick W. Abbott, M. Am. Soc. C. E., General Superintendent.

The party, consisting of 24 members and 30 guests, made the trip from Denver to Boulder over the Colorado and Southern Railway, through the courtesy of A. D. Parker, Vice-President, and C. W. Cowan, M. Am. Soc. C. E., Chief Engineer. From Boulder the party was taken, by tally-ho, up Boulder Cañon to the power-house and construction camp of the Company. After inspecting these, the members of the party were taken, in construction tram cars, up the side of the mountain, along the penstock, to the equalizing reservoir. On their return to the construction camp, supper was served. The return trip to Denver was made over the Interurban Line.

June 11th, 1910.—The meeting was called to order at 8.30 P. M.; Vice-President George G. Anderson in the chair; H. J. Burt, Secretary; and present, also, 20 members and 4 guests.

The minutes of the April meeting and the report of the excursion which took the place of the May meeting, were read and approved.

The Secretary-Treasurer presented an informal report of the business for the year, and the Annual Report was ordered completed and printed for distribution after the June meeting.

In the absence of the President, the Vice-President made an address covering the operations of the Association for 1909-10.

The following officers were elected:

President, GEORGE G. ANDERSON.
Vice-President, CHARLES W. COMSTOCK.
Secretary-Treasurer, H. J. BURT.

A paper on the "Mosida Irrigation Project" was presented by L. B. Curtis, Assoc. M. Am. Soc. C. E., and discussed.

Mr. Anderson, Chairman of the Committee on Legislation, presented a progress report on the Licensing of Engineers. After discussion, the Committee was instructed to prepare its report for presentation to the Society at the Annual Convention.

The Secretary was instructed to tender to the Board of Control of the National Irrigation Congress, any assistance which the Association or its members may be able to render at the meeting of the Congress in Pueblo, in September, 1910.

Adjourned.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

Architekten-Verein zu Berlin, Wilhelmstrasse 92, Berlin W. 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, 718 Caxton Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Colorado Association of Members, Am. Soc. C. E., H. J. Burt, Secy., 235 Equitable Building, Denver, Colo.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 803 Fulton Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur- und Architekten-Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur- und Architekten-Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE LIBRARY

(From May 10th to August 1st, 1910)

DONATIONS*

HANDBOOK OF COST DATA FOR CONTRACTORS AND ENGINEERS.

A Reference Book Giving Methods of Construction and Actual Costs of Materials and Labor on Numerous Engineering Works. By Halbert P. Gillette, M. Am. Soc. C. E. Second Edition. Morocco, 7¼ x 4¾ in., illus., 24 + 1854 pp. Chicago and New York, The Myron C. Clark Publishing Co., 1910. $5.00.

In writing the first edition of this work, the author states that his object was to place before the Contractor the most economical methods of construction and operation, and the unit costs of every detail of such work. In this, the second edition, he states that many gaps in such costs have been filled, and that certain cost data have been added, which will permit the Engineer to ascertain the number of units in a structure of a given class and size, as well as the unit costs. Much space has been devoted to descriptions of how the work was done, the organization of the forces, and the machines used, the records being actual records taken from various sources. Systems of cost keeping are outlined in the first part of the book and samples of record cards and systems are shown. The Contents are: Introduction; Principles of Engineering Economics and Cost Keeping; Earth Excavation; Rock Excavation; Quarrying and Crushing; Roads, Pavements, and Walks; Stone Masonry; Concrete and Reinforced Concrete Construction; Water Works; Sewers; Timberwork; Buildings; Railways; Bridges and Culverts; Steel and Iron Construction; Engineering and Surveys; Miscellaneous Cost Data; Index.

WROUGHT=PIPE DRAINAGE SYSTEMS.

By J. J. Cosgrove. Cloth, 9 x 6 in., illus., 145 pp. Pittsburg, Standard Sanitary Mfg. Co., 1909. $2.00.

This volume is offered with the hope that it will be found helpful by those engaged in the installation of iron pipe systems, the text, with the exception of one chapter which is devoted to the taking of measurements for wrought-pipe drainage systems, being, it is stated, applicable to any system of piping which is put together with screw-threads, for heating and refrigerating systems, pipe lines, drive wells, power plants, etc. The Contents are: Materials for Wrought-Pipe Drainage Systems; Working Wrought Pipe; Pipe Cutting and Threading Tools; Wrought-Pipe Fittings; Recessed Drainage Fittings; Bending Wrought Pipe; Making-Up Pipe; Measurements and Sketches; Planning the Work; Installing Wrought-Pipe Drainage Systems; Working Polished Brass and Nickel-Plated Pipe; Welding Wrought Pipes by Thermit Process; Index.

A CONCISE TREATISE ON REINFORCED CONCRETE.

A Companion to "The Manual of Reinforced Concrete." By Charles F. Marsh, M. Am. Soc. C. E. Cloth, 9 x 6 in., illus., 8 + 225 pp. New York, D. Van Nostrand Company, 1910. $2.50. (Donated by the Author and Publishers.)

A series of lectures on reinforced concrete was given by the author at the City and Guilds of London Technical College during 1908-09. The subject-matter of these lectures, considerably enlarged, has been embodied in this book, and the author hopes that, with "The Reinforced Concrete Manual," it may form a treatment of the subject which will be complete enough for all practical purposes. The preface states that lengthy descriptions of systems of construction, and of experiments and tests, have been omitted, but that the results of tests and the conclusions to be drawn from them have received full consideration. A short description of methods of reinforcement necessary to good design is given in the concluding chapter. The Chapter Headings are: Properties; Behaviour Under Loading; Necessary Assumptions for Purposes of Calculation; Methods of Calculation; Methods of Reinforcement; Index.

---

* Unless otherwise specified, books in this list have been donated by the publishers.

CATECHISM OF CENTRAL STATION GAS ENGINEERING IN THE UNITED STATES.

Compiled From the Questions and Answers Sent Out to the Practical Class, Trustees Gas Educational Fund, by the Secretary. Cloth, 9 x 6 in., illus., 21 + 683 pp. New York, Trustees Gas Educational Fund, 1909. $5.00.

The subject-matter contained in this volume has been compiled from questions and answers sent out to members of the Practical Class, which, from 1895 to 1899, was taught by correspondence by the Committee on Education of the American Gas Light Association and subsequent to that time by the Trustees Gas Educational Fund. These questions and answers have already appeared in the *Proceedings* of the American Gas Light Association and the American Gas Institute. Many requests have been made, however, that they be published in one volume and arranged by subject, and they are here presented in that form. Although primarily intended to aid younger workers in the gas business to a better knowledge of the principles involved and the apparatus used in the work, it is hoped that the book will be of some service to the older workers in recalling to them the reasons for accepted methods of operation. The Contents are: General Definitions; Manufacturing Materials: Bituminous Coal; Anthracite Coal; Gas Oils. Manufacturing Plants—Construction and Operation: Distinctively Coal Gas; Distinctively Carburetted Water Gas; Common to Both Coal and Carburetted Water Gas. Distribution System and Consumers' Appliances; Chemical; Physical; Masonry Construction; Miscellaneous; Index.

PRACTICAL TALKS ON CONTRACTING.

Being Reprints from *The Contractor* of Valuable Papers. By Frank B. Gilbreth, C. A. Worden, A. O. Davison, and E. S. Hanson. Cloth, 9 x 5½ in., illus., 128 pp. Chicago, The Contractor Publishing Company, 1910. $1.50.

As stated in the secondary title, this volume consists of reprints of articles on the successful systematization, organization, equipment and operation of contracting work, which have already appeared in *The Contractor.* The Contents are: Systematizing a Contractor's Office; Organization—How to Effect and Maintain It; Between Profit and Loss; Office System for Construction Work; Liability Insurance for Contractors; Important Things to Consider in Estimating; Purchasing Records for Contractors; Tool and Equipment Records; Contractor's Daily Reporting System; Earthwork Records; The Operation of Camps and Commissaries; How Contractors Use Photography.

HIGH MASONRY DAM DESIGN.

By Charles E. Morrison and Orrin L. Brodie, Associate Members, Am. Soc. C. E. Cloth, 9¼ x 6 in., illus., 4 + 103 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1910. $1.50. (Donated by Mr. Morrison.)

In the method of analysis for calculating the cross-sections of high masonry dams devised by Edward Wegmann, M. Am. Soc. C. E., and published in the Report of the Aqueduct Commissioners of New York City, for July 25th, 1887, the authors state that no account is taken of the effects of uplift due to water permeating the mass of masonry, and of ice thrust acting at the surface of the water in the reservoir. In this book, they have endeavored to supply these omissions, and to prepare a textbook containing a general treatment of these factors as required by recent practice, together with a brief statement in regard to late investigations for determining accurately the variation of stress in masonry dams. The formulas relating to uplift, ice thrust, etc., have been used in part in connection with the design of the large dams for the new water supply for New York City, and the computations for the design of a high masonry dam are given to facilitate the comprehension and application of these formulas.

ORNAMENTAL CONCRETE WITHOUT MOLDS.

By A. A. Houghton. Cloth, 8 x 5 in., illus., 132 pp. New York, The Norman W. Henley Publishing Co., 1910. $2.00.

In a secondary title the author states that this work is a practical treatise explanatory of a system of moulding ornamental concrete units with templates, and that it contains additional information on the proper preparation of concrete for ornamental work, the proportionate size of the various units, and the reinforcement of work. It is further stated that it is a working manual, containing everything that a concrete worker needs to know to perfect the many styles of ornamental concrete without the purchase of expensive moulds. The Contents are: Advantages of This System; Construction of Templates; Preparing Concrete and Operating the Templates; Making the Templates for Cornice of the Tuscan, Doric, Ionic, Composite and Roman Corinthian Orders; Molding Dentils, Triglyphs, Modillions, Mutules, etc.; Explanation of Moldings Used; Archivolts and Arches with Templates for Molding; The Doric, Ionic and Corinthian Columns, Proportions, Method of Molding and Fluting; Bases and Capitals for Doric, Ionic and Corinthian Orders, Method of Molding; Pedestals, Piers and Imposts with Templates for Molding; Machine for Rapid Molding; Concrete Urns or Lawn Vases with Templates; Molding Ball and Cap; Water Tables; Facing Work; Monuments, Molding, Lettering, etc.; Hitching Posts, Grave Markers, etc.; Molding Concrete Fountain, Templates for Same; Molding Garden Seats and Benches; Balusters, Lavatories, Jardinieres and Flower Pots; Reinforcement of Work, How to Make; Ornamental Moldings; Index.

CONCRETE FROM SAND MOLDS.

By A. A. Houghton. Cloth, 8 x 5 in., illus., 145 pp. New York, The Norman W. Henley Publishing Co., 1910. $2.00.

It has been the author's purpose to give, in this book, a complete and comprehensive explanation of the process of moulding every class of concrete work or "cast stone" with the use of moulds made from wet sand, and he states that this process, heretofore held as a trade secret, will successfully mould every class of ornamental concrete work desired. The Contents are: The Origin of the Sand Mold Process of Molding Concrete and the Value of Same; The Principle of the Process of Mixing and Preparing the Sand; Preparing the Material for and Hardening Molds; Making Sand Molds from Wood and Metal Patterns; Making Molds from Clay, Plaster or Concrete Patterns; Using Division Plates Between Sections of Flask to Make the Parting; Cores, How to Make and Use with Sand Molds; Combining Molds to Mold Large Work Monolithic; Methods of Combining Molds to Cast Large Monolithic Concrete Work; Making Rock Effects with Sand Molds; Ornamental Work from Sample Patterns; A Simple Lathe for Turning Sand Molds, Patterns and Cores; Molding "Cast Stone" Concrete Blocks for Hollow Walls, etc.; Molding Concrete Block with Sand Molds; Facing Molds with White Sand, Crushed Granite, etc.; Index.

"HÜTTE": TASCHENBUCH FÜR EISENHÜTTENLEUTE.

Herausgegeben vom Akademischen Verein Hütte E. V. Cloth, 7½ x 5 in., illus., 16 + 946 pp. Berlin, Wilhelm Ernst & Sohn, 1910. 15 Marks. (Donated by Author and Publishers.)

The metallurgical engineer, it is stated, has never had the help of a practical pocket-book in his work, and the compilers hope that this work will fill this need. It is not a text-book, it is said, and, therefore, all historical references have been omitted, the compilers' aim having been to present a concise statement of the fundamental principles and practices of the science of metallurgy in such a manner as to bring out their practical application. The book is intended primarily for the use of the metallurgical engineer, but it is hoped that it may prove of interest to all who are working along the same lines, especially the manufacturers of blast furnaces, etc. Each chapter has been written or the material for it has been supplied by a specialist on the subject. In order not to delay the publication of the work, several desirable subjects were omitted, among them the comprehensive treatment of auxiliary machines. It is hoped to enlarge succeeding editions to include a statement of the development of metallurgical science. The Contents are: Hilfswissenschaften und Wissenschaftliche Grundlagen; Feuerungskunde; Maschinen-Hilfs- und Nebenbetriebe; Eisen- und Stahlerzeugung und Giesserei; Weiterverarbeitung; Anhang.

HYDRAULIC ELEVATORS.

Their Design, Construction, Operation, Care and Management. By William Baxter, Jr. Cloth, 9¼ x 6¼ in., illus., 326 pp. New York and London, McGraw-Hill Book Company, 1910. $2.50.

The subject-matter contained in this book has already appeared in serial form in *Power*. In it the author gives descriptions of all the standard makes of hydraulic lifts and elevators, from the simplest to the most complicated forms, together with detailed accounts of their mechanism and the advantages and disadvantages governing the selection of the type best suited to any particular case, as well as the differences between the same types as constructed by different builders. The author also discusses where and how the various types of elevators get out of order and gives detailed directions as to repairs and maintenance. The Chapter headings are: Fundamental Principles of Different Types; Counterbalancing; Plunger Hydraulic Elevators; Horizontal Cylinder Machines—"Pushing" and "Pulling" Types; Counterbalancing the Lifting Ropes of Elevator Cars; General Arrangement of Hydraulic Elevator Systems; Vertical Hydraulic Elevators; Low Pressure Vertical Type Elevator Lever Control; Pilot-Valve Control-Regulating Valves; Safety Devices; Good Features of Magnetic Valve Control, etc.; Magnetic Controller for Battery Current; Double-Power Hydraulic Elevator System; Otis Running-Rope System; Principal Causes of Disordered Mechanism and How Prevented or Removed, etc.; Automatic Devices Used for Stopping Cars at Top and Bottom Landings, etc.; Effect of Stretching of the Ropes; Construction of Traveling-Sheave Frames, Foundations and Supports; Why the Piston is Weighted; The Electrical Features of Vertical-Cylinder Elevators; Horizontal Hydraulic Elevators; Description of the "Pulling" Type of Horizontal Elevator; The Morse-Williams "Pulling" Machine; Crane Horizontal "Pushing" Machine, How the Stop-Motion Gets Out of Adjustment, etc.; Crane Horizontal "Pushing" Machine, Description of Automatic Stop-Valve, etc.; Construction Details of the Whittier Machine; Overhead Sheaves and Bearings, etc.; Details of the Morse and Williams Pulling Machines; High-Pressure Hydraulic Elevators; Operation of the Main and Pilot Valves of the Otis Vertical Elevator; Construction and Operation of the Accumulators and the Automatic Valves Used with Them; Automatic Stop-Valves Used with Otis High-Pressure Machines; Adjustment and Care of Automatic Stop-Valves and Mechanism of High-Pressure Elevators; Stop-Valves Used with Accumulators; Plunger Elevators; Operation of Main and Pilot Control Valves, etc.; Rack-and-Pinion Valves for Otis Freight Elevators, etc.; Replacing Worn Shoes; The "Standard" Plunger Elevator; Operation of the Pilot and Main Valves; Construction and Operation Details of the Highest Type of Passenger Elevator Made by the Standard Plunger Elevator Company; Practical Instructions in the Care and Management of the "Standard" Plunger Elevator; Hand-Rope Control for Freight Elevators, etc.; Index.

PREMIER CONGRÈS FRANÇAIS DU FROID.

Lyon, 1er-3 Octobre, 1909. Comptes Rendus, Rapports et Communications du Congrès. Publiés par L'Association Française du Froid. Paper, 9½ x 6 in., illus., 187 pp. Paris, Siège Social de L'Association, 10 rue Denis-Poisson. 10 francs.

It is stated that the publication of this book is of the greatest importance from a technical, scientific and practical viewpoint. It contains a complete report of the discussions on refrigeration which took place before the Congress, and in which many French scientists, engineers, and manufacturers interested in the subject, took part. From these discussions, it is said that one may obtain a complete knowledge of the various applications of refrigeration as practiced in France and of the efforts which have been made toward improving and cheapening the methods used. The Contents are: Organisation du Congrès; Gaz Liquéfiés et Matériel Frigorifique; Applications Générales du Froid; Transports Frigorifiques; Legislation.

Gifts have also been received from the following:

Aberthaw Constr. Co. 2 pam.
Aluminum Co. of America. 1 pam.
Am. Inst. of Min. Engrs. 1 vol.
Am. Ry. Assoc. 1 pam.
Am. Soc. of Agri. Engrs. 1 vol.
Am. Soc. of Heating and Ventilating Engrs. 1 bound vol.
Amsterdam, N. Y.-Water Commrs. 1 pam.
Architekten-Verein zu Berlin. 1 vol.
Assoc. Amicale des Anciens Elèves de l'Ecole Centrale des Arts et Manufactures. 1 vol.
Assoc. Parisienne des Propriétaires d'Appareils à Vapeur. 1 pam.
Atchison, Topeka & Santa Fe Ry. System. 1 pam.
Baltimore, Md.-Water Board. 1 pam.
Bandy, J. M. 1 pam.
Bixby, W. H. 1 vol., 1 map.
Bloomfield, N. J.-Town Council. 1 pam.
Boston, Mass., Public Library. 1 pam.
Boston Soc. of Civ. Engrs. 1 pam.
Bourne, Jonathan, Jr. 1 pam.
Bowers, George. 1 pam.
British Assoc. for the Advancement of Science. 1 bound vol.
British Columbia-Minister of Mines. 1 pam.
British Fire Prevention Committee. 16 vol.
Brooklyn Engrs.' Club. 1 bound vol.
Bryan, I. J. 9 pam.
Burton, T. E. 12 pam.
Cal.-Board of Harbor Commrs. of Port of Eureka. 2 pam.
Cal.-Board of State Harbor Commrs. 1 bound vol.
Cal.-State Board of Forestry. 1 pam.
Cal.-State Board of Health. 1 pam.
Cal.-State Min. Bureau. 3 pam.
Canada-Comm. of Conservation. 2 vol.

Canada-Dept. of Mines. 2 pam.
Canada-Geol. Survey. 1 pam.
Canadian Min. Inst. 1 vol.
Canadian Soc. of Civ. Engrs. 1 pam.
Cape of Good Hope-General Mgr. of Rys. 1 pam.
Central South African Rys. 1 pam.
Chemin de Fer de Paris à Orléans. 1 pam.
Chemin de Fer du Nord. 1 pam.
Chemin de Fer Métropolitain de Paris. 3 pam.
Chemins de Fer de l'Est. 1 vol.
Chemins de Fer de Paris à Lyon et la Méditerranée. 5 pam.
Chicago Sanitary Dist. 1 bound vol.
Cincinnati, Ohio-Bureau of Municipal Research. 2 pam.
Colorado-Agri. Exper. Station. 6 pam.
Colorado-R. R. Comm. 2 pam.
Colorado-State Agri. Coll. 1 pam.
Columbia Univ. 1 vol.
Congreso Cientifico, 4°. 1 pam.
Conn.-Saybrook and Lyme Conn. River Bridge Comm. 1 pam.
Conn.-State Forester. 1 pam.
Conn. Soc. of Civ. Engrs. 1 pam.
Conservatoire National des Arts et Metiers. 2 pam.
Conway, W. H. 1 pam.
Debar, Joseph. 1 bound vol.
Delaware Coll. 1 pam.
Depew, Chauncey M. 1 pam.
Dodge, G. M. 1 vol.
Donahue, J. H. 1 pam.
Dyckerhoff & Söhne. 2 pam.
East Indian Ry. Co. 1 pam.
Editors of *The Polytechnic Engr.* 1 vol.
Egyptian Delta Light Rys. 1 pam.
Eng. Assoc. of New South Wales. 1 bound vol.
Ericson, J. E. 3 bound vol.
Erie, Pa.-Commrs. of Water-Works. 1 pam.
Evans, R. R. 1 vol.
Fitchburg, Mass.-City Engr. 1 pam.
Florida-State Board of Health. 1 pam.
Florida-State Geol. Survey. 1 vol., 3 pam.
Fort, J. F. 2 pam.
Gallinger, J. H. 1 vol.
Gehler, W. 1 bound vol.
Geneva, N. Y.-City Engr. 1 pam.
Georgia-R. R. Comm. 1 vol.
Germany-Kgl. Preussisches Ministerium der Offentlichen Arbeiten. 14 pam.
Gloucester, Mass.-Water Commrs. 1 pam.
Gotshall, W. C. 70 bound vol., 4 vol.
Great Britain-Patent Office. 2 pam.
Halifax, N. S.-City Engr. 1 pam.
Hardenburg, Norma. 1 pam.
Hartford, Conn.-Board of Water Commrs. 1 pam.
Harvard Univ. 1 vol.
Hering & Fuller. 1 vol.
Herrick, G. P. 4 pam.
Hiroi, Isami. 1 bound vol.
Hodgdon, Frank W. 1 bound vol.
Holyoke, Mass.-City Engr. 1 pam.
Horton, R. E. 1 pam.
Howard, J. W. 1 pam.
Idaho-State Insp. of Mines. 1 pam.
Illinois-Bureau of Labor Statistics. 2 bound vol.
Illinois-State Board of Equalization. 2 bound vol.
Illinois-State Geol. Survey. 1 bound vol.
Illinois-State Water Survey. 2 pam.
Illinois, Univ. of-Agri. Exper. Station. 1 pam.
Illinois Soc. of Engrs. and Surv. 1 vol.
India-Ry. Board. 2 pam.
Indian Midland Ry. Co. 1 pam.
Indiana-State Board of Forestry. 1 pam.
Indiana-State Board of Health. 1 bound vol., 4 pam.
Institution of Mech. Engrs. 1 vol.
Institution of Min. and Metallurgy. 1 pam.
Iowa-Geol. Survey. 6 bound vol.
Iowa-State Board of R. R. Commrs. 4 pam.
Iowa Eng. Soc. 1 pam.
Iowa State Coll. of Agri. and Mechanic Arts. 1 vol., 2 pam.
Jackson, F. H. 3 pam.
Kähler, W. 1 pam.
Kansas-State Board of Health. 1 bound vol.
Kansas-Tax Comm. 1 pam.
Kansas, Univ. of. 2 vol.
Kentucky-Insp. of Mines. 3 bound vol.
Kentucky-State Auditor. 1 bound vol.
Kentucky, State Univ. of. 1 vol.
Kirkpatrick, W. G. 1 pam.
Koninklijk Inst. van Ingenieurs. 1 pam.
Lawrence, Mass.-Water Board. 1 pam.
Lewiston, Me.-Board of Water Commrs. 1 pam.
Lobeck, C. O. 10 bound vol.
Long Island R. R. Co. 1 pam.
Lorimer, William. 10 pam.
Louisiana-Board of State Engrs. 1 vol.
Louisiana-Geol. Survey. 8 pam.
Louisiana-R. R. Comm. 2 pam.
Louisiana-State Board of Appraisers. 2 pam.
Lowell, Mass.-Water Board. 1 pam.
Lynchburg, Va.-City Clerk. 9 vol.
Madras, India-Public Works Dept. 1 bound vol., 1 vol.
Maine-Treasurer. 1 bound vol.
Manchester, N. H.-Board of Water Commrs. 1 pam.
Marlborough, Mass.-Water Commrs. 1 pam.
Maryland-Bureau of Statistics and Information. 1 vol.
Maryland-Geol. Survey. 2 bound vol.
Maryland-State Board of Health. 2 vol., 1 pam.
Mass.-Board of Gas and Electric Light Commrs. 1 vol.
Mass.-Board of R. R. Commrs. 1 bound vol.
Mass.-Bureau of Statistics. 2 pam.
Mass.-Charles River Basin Comm. 1 bound vol.
Mass.-Harbor and Land Commrs. 1 bound vol.
Mass.-Highway Comm. 1 bound vol., 8 pam.
Mass.-Joint Board on Green Harbor. 1 pam.
Mass.-Met. Water and Sewerage Board. 1 bound vol.
Mass.-Tax Commrs. 2 pam.
Met. Ry. Co. 1 pam.
Mexican Ry. Co., Ltd. 3 pam.
Mexican Southern Ry. Co., Ltd. 1 pam.
Mich.-Highway Dept. 1 pam.
Mich.-Secy. of State. 1 vol.

Mich.-State Insp. of Illuminating Oils. 1 pam.
Minnesota.-R. R. and Warehouse Comm. 1 bound vol.
Miss.-Board of Health. 1 pam.
Miss.-R. R. Comm. 1 bound vol.
Missouri-Bureau of Mines, Min., and Mine Inspection. 2 pam.
Missouri, Univ. of. 1 vol.
Montana-State Board of Land Commrs. 1 pam.
Montana Univ. 1 pam.
Montreal, Que.-Harbor Commrs. 1 pam.
Municipal Engrs. of the City of New York. 1 pam.
Murphy, John. 2 pam.
Natal-Gen. Mgr. of Rys. 1 pam.
National Assoc. of Mfrs. of the U. S. of America. 1 pam.
National Board of Fire Underwriters. 11 pam.
National Fire Protection Assoc. 2 pam.
National Lead Co. 2 pam.
Nebraska-Ry. Comm. 2 bound vol., 1 vol., 5 pam.
Nebraska-State Insp. of Oils. 1 pam.
New Bedford, Mass.-Supt. of Streets. 1 pam.
New England Water Works Assoc. 1 pam.
New Jersey-Board of Equalization of Taxes. 2 bound vol., 5 pam.
New Jersey-Board of R. R. Commrs. 1 bound vol.
New Jersey-Board of Tenement House Supervision. 1 bound vol.
New Jersey-Board to Re-Appraise Railroads and Canals. 1 pam.
New Jersey-Bureau of Shell Fisheries. 1 bound vol.
New Jersey-Riparian Commrs. 1 pam.
New Jersey-State Comptroller. 1 bound vol.
New Jersey-State Highway Comm. 1 pam.
New South Wales-Met. Board of Water Supply and Sewerage. 1 pam.
New York City-Board of Estimate and Apportionment. 1 pam.
New York City-Dept. of Docks and Ferries. 1 pam.
New York City-Met. Sewerage Comm. 1 bound vol., 1 pam.
New York City-Municipal Civil Service Comm. 1 bound vol.
New York State-Advisory Board of Cons. Engrs. 1 bound vol.
New York State-Dept. of Highways. 3 pam.
New York State-Forest, Fish and Game Comm. 1 map.
New York State-Museum. 1 bound vol.
New York State-Public Service Comm., First District. 9 pam.
New York State-Public Service Comm., Second Dist. 1 pam.
New York-State Engr. and Surv. 1 pam., 1 map.
New York and New Jersey Interstate Bridge Comm. 1 pam.
New York Chamber of Commerce. 1 bound vol.
New York City Record. 3 bound vol.
New York Testing Laboratory. 2 pam.
Newport, Ky.-Water-Works Dept. 1 pam.
North Carolina-Board of Health. 2 pam.
North Carolina-Geol. and Economic Survey. 7 pam.
North Dakota-State Board of Health. 1 pam.
Nova Scotian Inst. of Science. 4 pam.
O'Donnell, J. P. 1 bound vol.
Ohio-Board of Public Works. 1 pam.
Ohio-Chf. Insp. of Mines. 12 vol.
Ohio-Geol. Survey. 1 vol.
Ohio-Highway Dept. 2 bound vol., 7 pam.
Ohio-R. R. Comm. 2 bound vol.
Oklahoma-Corporation Comm. 1 pam.
Ontario, Canada-Provincial Board of Health. 1 pam.
Ontario Assoc. of Architects. 1 vol.
Oregon-Conservation Comm. 1 pam.
Oregon-R. R. Comm. 4 pam.
Oregon-State Board of Forestry. 1 pam.
Organization of City Officials for Standardizing Paving Specifications. 1 bound vol.
Oesterreichischer Ingenieur- und Architekten-Verein. 1 bound vol.
Pennsylvania-Dept. of Internal Affairs. 1 bound vol., 1 map.
Pennsylvania-Water Supply Comm. 1 bound vol.
Pennsylvania State Coll. 1 vol.
Peters, Madison C. 1 bound vol.
Pharr, Harry N. 1 pam.
Philippine Islands-Bureau of Forestry. 2 pam.
Poetsch, Charles J. 2 pam.
Porto Rico-Civ. Service Comm. 1 vol., 1 pam.
Providence, R. I.-Dept. of Public Works. 1 pam.
Providence, R. I., Pub. Library. 1 pam.
Punjab, India-Irrig. Dept. 1 pam.
Purdue Univ. 3 pam.
Randolph, Isham. 1 bound vol., 1 vol., 3 pam.
Rhode Island-Commr. of Dams and Reservoirs. 1 pam.
Rhode Island-Commrs. of Shell Fisheries. 1 pam.
Rhode Island-Dept. of Factory Inspection. 1 bound vol.
Rhode Island-State Board of Health. 1 bound vol.
Rhodesia Rys., Ltd. 1 pam.
Robinson, F. H. 1 pam.
Royal Soc. of Canada. 1 bound vol., 1 pam.
San Francisco, Cal., Merchants' Assoc.-Bureau of Inspection. 1 pam.
Schantung-Eisenbahn-Gesellschaft. 1 pam.
Smithsonian Institution. 2 vol., 9 pam.
Smoot, Reed. 2 pam.
Soc. for the Promotion of Eng. Education. 1 bound vol.
Soc. Générale des Chemins de Fer Economiques. 1 pam.
Soc. of Engrs. 1 bound vol.
Soc. of Naval Architects and Marine Engrs. 1 bound vol.
Somerville, Mass.-City Council. 1 bound vol., 2 pam.
South Carolina-Comptroller-Gen. 2 pam.
South Carolina-R. R. Comm. 2 bound vol., 1 vol., 2 pam.
South Carolina, Univ. of. 2 pam.
South Dakota, Univ. of. 1 pam.
South Eastern Ry. Co. 1 pam.

Springfield, Mass.-Board of Water Commrs. 1 vol.
Springfield, Mass.-City Engr. 1 pam.
Springfield, Mass.-Supt. of Streets and Sewers. 1 pam.
Stuart, Francis Lee. 1 pam.
Switzerland-Landeshydrographie. 1 pam.
Texas-R. R. Comm. 2 pam.
Texas, Univ. of. 4 pam.
Thompson, Slason. 1 pam.
Toronto, Univ. of. 1 vol.
Townsend, C. McD. 1 pam.
Transvaal-Bewaarplaatesen Comm. 1 pam.
Transvaal-Land and Irrig. Dept. 4 pam.
Transvaal-Mines Dept. 1 pam.
Transvaal-Power Companies Comm. 1 pam.
Tribus, Louis L. 1 bound vol.
U. S.-Bureau of Statistics. 2 bound vol.
U. S.-Bureau of the Census. 2 bound vol.
U. S.-Chf. of Engrs. 1 bound vol., 26 pam.
U. S.-Civ. Service Comm. 7 bound vol., 1 vol.
U. S.-Coast and Geodetic Survey. 2 bound vol., 1 vol.
U. S.-Corps of Engrs. 2 pam.
U. S.-Dept. of Agriculture. 3 pam.
U. S.-Director of the Mint. 6 bound vol.
U. S.-Geol. Survey. 16 pam., 62 maps.
U. S.-Hydrographic Office. 2 pam.
U. S.-Interstate Commerce Comm. 3 bound vol., 4 pam.
U. S.-National Museum. 2 pam.
U. S.-Office of Exper. Stations. 2 pam.
U. S.-Office of Public Roads. 2 pam.
U. S.-Reclamation Service. 1 vol.
U. S.-War Dept. 3 vol., 3 pam.
U. S.-Weather Bureau. 2 pam.
Univ. Club. 1 bound vol.
Utah-Conservation Comm. 1 bound vol.
Utah-Legislature. 1 pam.
Utah-State Engr. 1 pam.
Verein Deutscher Ingenieure. 1 pam.
Vermont-State Board of Health. 1 pam.
Vermont-State Forester. 1 pam.
Victorian Inst. of Surv. 1 bound vol.
Virginia-Commr. of Health. 1 pam.
Virginia-Geol. Survey. 2 pam.
Virginia-State Highway Commr. 1 pam.
von Geldern, Otto. 1 pam.
Washington-State Insp. of Coal Mines. 2 pam.
Waterbury, Conn.-City Engr. 1 pam.
West Virginia-Dept. of Mines. 1 vol.
Williams, Frank M. 2 bound vol.
Wilmington, Del.-Board of Park Commrs. 1 pam.
Wisconsin-Board of Health. 3 pam.
Wisconsin-State Superv. of Illuminating Oils. 1 pam.
Woburn, Mass.-City Govt. 1 bound vol.
Woburn, Mass.-Water Dept. 1 pam.
Woodworth, R. B. 1 pam.
Woonsocket, R. I.-Water Dept. 1 pam.
Worcester, Mass.-City Engr. 1 pam.
Worcester, Mass.-Supt. of Sewers. 1 pam.
Wyoming-State Engr. 2 pam.
Yale Univ. 1 pam.

BY PURCHASE

Elektrotechnik in Einzeldarstellungen, Unter Mitwirkung Hervorragender Fachmänner, Herausgegeben von Dr. Gustav Benischke. Zwölftes Heft. Das Elektrische Bogenlicht, Physikalisch-Technische Grundlagen der Lichterzeugung durch Elektrische Entladungsvorgänge. Von Ewald Rasch. Friedrich Vieweg und Sohn, Braunschweig, 1910.

Railway Signaling in Theory and Practice. By James Brandt Latimer. Mackenzie-Klink Publishing Company, Chicago, 1909.

Supplement to the Directory to the Iron and Steel Works of the United States; Containing a Thorough Revision of the Directory Published in 1908, with Many New Descriptive Features. Compiled by the American Iron and Steel Association. Corrected to March, 1910. American Iron and Steel Association, Philadelphia, 1910.

Der Gehängebau. Von Franz Leiner. Wilhelm Engelmann, Leipzig, 1909.

Die Bestimmung der Querschnitte von Staumauern und Wehren aus Dreieckigen Grundformen. Von E. Link. Julius Springer, Berlin, 1910.

Wasserbau. Vierter Band des Handbuches für Eisenbetonbau. Zweite Auflage. Uferbefestigungen, Schleusen, Leuchttürme und Leuchtbaken, Hellinge, Schiffsgefässe, Wehre, Staudämme und Talsperren. Bearbeitet von F. W. Otto Schulze, L. Kauf, E. Brugsch. Wilhelm Ernst & Sohn, Berlin, 1910.

Flüssigkeitsbehälter, Röhren, Kanäle. Fünfter Band des Handbuches für Eisenbetonbau. Zweite Auflage. Flüssigkeitsbehälter, Röhrenförmige Leitungen und Offene Kanäle, Aquadukte und Kanalbrücken. Bearbeitet von R. Wuczkowski, Fr. Lorey. Wilhelm Ernst & Sohn, Berlin, 1910.

Fuel and Refractory Materials. By A. Humboldt Sexton. New and Revised Edition. D. Van Nostrand Company, New York, 1910.

Descriptive Meteorology. By Willis L. Moore. D. Appleton and Company, New York, 1910.

Montclair; The Preservation of its Natural Beauty and its Improvement as a Residence Town. Report of John Nolen, Landscape Architect, to the Municipal Art Commission, and the Commission's Recommendations to the Citizens of Montclair. Montclair, N. J., 1909.

Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, insbesondere aus den Laboratorien der Technischen Hochschulen. Herausgegeben vom Verein Deutscher Ingenieure. Heft 83–87. Julius Springer, Berlin, 1910.

The Copper Handbook; a Manual of the Copper Industry of the World. Vol. IX. Compiled and Published by Horace J. Stevens, Houghton, Mich., 1909.

Mosquito or Man? The Conquest of the Tropical World. By *Sir* Rupert W. Boyce. E. P. Dutton & Company, New York, 1909.

Forscherarbeiten auf dem Gebiete des Eisenbetons; Einflusslinien für die Berechnung Paralleler Vierendeel-Träger. Von Dr. Ing. Wenzel St. Ritter von Balicki. Wilhelm Ernst & Sohn, Berlin, 1910.

Grund= und Mauerwerksbau. Dritter Band des Handbuches für Eisenbetonbau. Zweite Auflage. Grundbau; Mauerwerksbau. Bearbeitet von F. von Emperger, A. Nowak. Wilhelm Ernst & Sohn, Berlin, 1910.

The Century Dictionary and Cyclopedia; A Work of Universal Reference in all Departments of Knowledge, with a New Atlas of the World. Vol. XI–XII. The Century Co., New York, 1909.

Building Construction and Superintendence. By F. E. Kidder. Revised and Enlarged, by Thomas Nolan. Part I, Ninth Edition—Revised: Masons' Work. The William T. Comstock Company, New York, 1910.

Elementary Treatise on Physics, Experimental and Applied, for the Use of Colleges and Schools; Translated from Ganots' Éléments de Physique, by E. Atkinson. Seventeenth Edition, Edited by A. W. Reinold. William Wood and Company, New York, 1905.

Report of the State Earthquake Investigation Commission. Volume II. The Mechanics of the Earthquake. By Harry Fielding Reid. Carnegie Institution of Washington, Washington, D. C., 1910.

The Architect's and Builder's Pocket-Book; A Handbook for Architects, Structural Engineers, Builders, and Draughtsmen. By Frank E. Kidder. Fifteenth Edition, Revised. John Wiley & Sons, New York, 1909.

Asbestos; Its Properties, Occurrence, and Uses, With Some Account of the Mines of Italy and Canada. By Robert H. Jones. Crosby Lockwood and Son, London, 1890.

The Assistant Engineer. By Jean P. Genthon. Pts. 1–8. The Chief Publishing Co., New York, 1907–09.

The Cyanide Handbook. By J. E. Clennell. McGraw-Hill Book Company, New York, 1910.

Hygiène Générale des Villes et des Agglomérations Communales. Par E. Macé, Ed. Imbeaux, Albert Bluzet, Paul Adam. J.-B. Baillière et Fils, Paris, 1910.

Moody's Manual of Railroads and Corporation Securities, 1910. Eleventh Annual Number. George Hosking, Editor. Moody Manual Company, New York, 1910.

Proceedings of the Sixteenth Annual Convention of the American Society of Municipal Improvements, held at Little Rock, Arkansas, November 9th, 10th, 11th, 1909. S. E. Tate Printing Company, Milwaukee.

The Depreciation of Factories, Mines and Industrial Undertakings and Their Valuation. By Ewing Matheson. Fourth Edition, Revised and Enlarged. Spon & Chamberlain, New York, 1910.

Metallography. By Cecil H. Desch. Longmans, Green & Co., New York, 1910.

Public Recreation Facilities. American Academy of Political and Social Science, Philadelphia, 1910.

SUMMARY OF ACCESSIONS

(From May 10th to August 1st, 1910)

Donations (including 114 duplicates)	787
By purchase	40
Total	827

MEMBERSHIP

ADDITIONS

(May 10th, 1910, to August 1st, 1910)

MEMBERS

		Date of Membership.
Ayres, Willis Edward. Cons. and Contr. Engr., Randolph Bldg., Memphis, Tenn.		May 31, 1910
Bamford, William Brokaw. Archt. and Cons. Engr., Cor. Chestnut and Hamilton Ave., Trenton, N. J.	Jun. Assoc. M. M.	June 2, 1903 Oct. 5, 1904 May 31, 1910
Barnes, Osgood Frost. Div. Engr., Erie R. R., Susquehanna, Pa.		June 30, 1910
Blum, Louis Philip. Asst. Engr., The W. G. Wilkins Co.; Address, 204 Broadway, North Side, Pittsburg, Pa.		May 31, 1910
Brown, Walter Henry. 1034 West 36th Pl., Los Angeles, Cal.		May 31, 1910
Buel, Emott Davis. Engr. for John Monks & Sons, 82 Beaver St., New York City		June 30, 1910
Carlin, Joseph Patrick. Secy. and Treas., P. J. Carlin Constr. Co., 16 East 23d St., New York City	Jun. Assoc. M. M.	Oct. 4, 1898 Sept. 6, 1905 May 31, 1910
Cole, Harry Outen. Asst. Engr., Pacific Div., Isthmian Canal Comm., Corozal, Canal Zone, Panama	Assoc. M. M.	Jan. 4, 1905 May 3, 1910
Connor, William Durward. Maj., Corps of Engrs., U. S. A., Commanding Co. B, 1st Battalion of Engrs., Washington Barracks, Washington, D. C.	Assoc. M. M.	Jan. 7, 1903 May 31, 1910
Cornish, Lorenzo Dana. Designing Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Jun. Assoc. M. M.	April 5, 1904 Feb. 7, 1906 June 30, 1910
Cowles, William Pierce. Cons. Engr., 925 New York Life Bldg., Minneapolis, Minn.	Assoc. M. M.	Nov. 7, 1906 May 3, 1910
Denise, Charles Meirs. Contr. Engr., McClintic-Marshall Constr. Co., 1214 First National Bank Bldg., Chicago, Ill.		May 3, 1910
Diehl, George Conrad. 575 Ellicott Sq., Buffalo, N. Y.		May 31, 1910
Dimock, Arthur Herbert. Asst. City Engr., City Hall, Seattle, Wash.		May 31, 1910
Elliott, James William. Care, Hamilton Bridge Works, Hamilton, Ont., Canada	Assoc. M. M.	April 6, 1909 June 30, 1910
Fuller, Almon Homer. Prof. of Civ. Eng. and Dean, Coll. of Eng., Univ. of Washington, University Station, Seattle, Wash.	Jun. Assoc. M.	April 4, 1899 Feb. 4, 1902 May 3, 1910
Gehler, Gustav Willy. Chf. Engr., Vice-Pres. and Mgr., Tech. Div., Dyckerhoff & Widmann; Address, Kurfurstenstr. 1, Dresden, Germany		April 5, 1910

MEMBERS (*Continued*).

		Date of Membership.
Grant, William. 2420 R St., Lincoln, Nebr.		Feb. 1, 1910
Haines, Eugene Grove. Asst. Engr., Public Service Comm., First Dist., Fifth Div., New York City, 4 Court Sq., Brooklyn, N. Y.	Assoc. M. M.	May 1, 1901 April 5, 1910
Hamilton, Frank Henry. City Engr. and Commr. of Bldgs., City Hall, Springfield, Ill.		June 30, 1910
Hammond, Charles Lincoln. Engr., Conners Bros. Co. (Res., 69 Forest St.), Lowell, Mass.		May 3, 1910
Hastings, Frank Arnold. P. O. Box 312, Martins Ferry, Ohio	Assoc. M. M.	Dec. 3, 1902 May 31, 1910
Henry, George Jackson, Jr. Chf. Engr., The Pelton Water Wheel Co., 1099 Monadnock Bldg., San Francisco, Cal.		April 5, 1910
Hodgman, Harry. U. S. Junior Engr., Amherstburg, Ont., Canada	Assoc. M. M.	Mar. 2, 1904 May 31, 1910
Holmes, Lemuel. Bridge Engr., New York State Highway Comm.; Address, 12 South Hawk St., Albany, N. Y.		Mar. 1, 1910
Horton, Robert Elmer. 57 North Pine Ave., Albany, N. Y.	Assoc. M. M.	Dec. 7, 1904 May 31, 1910
How, Richard Willis. R. 3, Perry, N. Y.	Jun. Assoc. M. M.	June 6, 1899 Mar. 1, 1905 June 30, 1910
Hoyt, Warren Albert. 455 Old Colony Bldg., Chicago, Ill.		June 30, 1910
Hughes, John Wilbur. 31 East 9th St., Erie, Pa.		June 30, 1910
Hunter, Joseph Wray. State Highway Commr. of Pennsylvania, Jenkintown, Montgomery Co., Pa.		May 3, 1910
Jacobsen, Hans Peter Rude. Cons. Civ. Engr., Randalls Blk., Oyster Bay, N. Y.		May 3, 1910
Jeme, Tien Yow. Chf. Director and Chf. Engr., Imperial Peking-Kalgan Ry., and Associate Director, Ichang-Wanhsien Sec., Szechuen-Chuenhan Ry., Peking, China		Nov. 30, 1909
Knight, Herbert Miller. Div. Engr., Baltimore Sewerage Comm., American Bldg., Baltimore, Md.		May 3, 1910
Leh, Elvin Ulysses. Supt., Cowell Portland Cement Co.'s Plant, Cowell, Cal., *via* Bay Point		May 31, 1910
Leonard, Clifford Milton. Pres. and Treas., Leonard Constr. Co., McCormick Bldg., Chicago, Ill.	Assoc. M. M.	Oct. 2, 1907 May 31, 1910
Lueder, Archibald Byron. Engr., Merrill-Ruckgaber Co., New York City; Address, 31 Ridgedale Ave., Morristown, N. J.		May 31, 1910
MacVicar, John Duncan. Care, White Bros., Ovando, Mont.		May 31, 1910

MEMBERS (*Continued*).		Date of Membership.
McCullough, Ernest. 2147 Sherman Ave., Evanston, Ill.		May 31, 1910
Moore, Egbert Jessup. Chf. Engr., Turner Constr. Co., 11 Broadway, New York City; Address, 80 Cornell Ave., Yonkers, N. Y.	Jun. Assoc. M. M.	Mar. 31, 1903 Feb. 7, 1906 May 31, 1910
Moorshead, Thomas Courtney. Chf. Engr., Ill. Terminal R. R.; Supt. of Constr., Illinois Glass Co., Alton, Ill.	Assoc. M. M.	Mar. 1, 1905 June 30, 1910
Morse, Walter Levi. Res. Engr., Grand Central Terminal, N. Y. C. & H. R. R. R., Grand Central Station, New York City		May 3, 1910
Oakes, John Calvin. Capt., Corps of Engrs., U. S. A., Room 415 Custom House (P. O. Box 716), Cincinnati, Ohio	Assoc. M. M.	May 1, 1907 May 31, 1910
Patten, William Nickels. Asst. Constr. Mgr., Stone & Webster Eng. Corp., 147 Milk St., Boston, Mass.		June 30, 1910
Perrine, Ren Brown. Archt. and Engr. (Prack & Perrine), J. M. S. Bldg., South Bend, Ind.		May 31, 1910
Poss, Victor Henry. Engr. with Reid Bros., 15 Claus Spreckels Bldg., San Francisco, Cal.		April 5, 1910
Potts, Clyde. Civ. and San. Engr., 30 Church St., New York City	Jun. Assoc. M. M.	Dec. 3, 1901 Oct. 4, 1905 June 30, 1910
Quimby, Charles Henry, Jr. Res. Engr., New York, Westchester & Boston Ry., 220 South Fulton Ave., Mt. Vernon, N. Y.	Assoc. M. M.	Dec. 4, 1907 June 30, 1910
Robinson, William Harper. Prin. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands		Mar. 1, 1910
Rollins, Charles Ward. Chf. Engr., Neches Canal, China, Tex.		April 5, 1910
Rostock, John Henry. Prin. Asst. Engr., U. S. Engr. Office, 39 Whitehall St., Room 710, New York City		May 3, 1910
Sanford, George Otis. Project Engr., U. S. Reclamation Service, Williston, N. Dak.	Assoc. M. M.	Mar. 7, 1906 Jan. 4, 1910
Sprague, Norman Salisbury. Supt., Bureau of Constr., City Hall, Pittsburg, Pa.	Assoc. M. M.	July 10, 1907 May 31, 1910
Stanley, Orrin Elmore. Asst. Engr., O. R. R. & Nav. Co., Celilo, Ore.	Assoc. M. M.	Oct. 7, 1908 May 31, 1910
Stephenson, James, Jr. State Engr., 301 Boise City National Bank Bldg., Boise, Idaho		April 5, 1910
Straub, Theodore Alfred. Vice-Pres. and Gen. Mgr., Ft. Pitt Bridge Works, 510 House Bldg., Pittsburg, Pa.		June 30, 1910
Sundstrom, Alfred Yngve. Bridge Engr., Mexican Ry., City of Mexico, Mexico	Assoc. M. M.	June 6, 1906 May 31, 1910

MEMBERS (*Continued*).

		Date of Membership.
Swift, William Everett. Div. Engr., Hudson River Div., New York Board of Water Supply, Cornwall-on-Hudson, N. Y......	Assoc. M. M.	Sept. 2, 1903 June 30, 1910
Vent, Frederick Goodman. Designer, Bridge Dept., C., B. & Q. R. R., 209 Adams St., Room 60, Chicago, Ill..		May 3, 1910
Vincent, James Irving. Asst. Engr., The Scherzer Rolling Lift Bridge Co. of Chicago, 220 Broadway, New York City....................................		June 30, 1910
Walker, Emery Lafayette. In Chg. of Maintenance of Plant and Constr., Baldwin Locomotive Works, Philadelphia, Pa..		May 3, 1910
Wardle, Edward Beaumont. Chf. Engr. for George F. Hardy, 309 Broadway, New York City..........................	Assoc. M. M.	Dec. 4, 1907 May 31, 1910
Whitman, Ezra Bailey. Div. Engr., Disposal Works, Sewerage Comm., Back River Sewage Disposal Works, Colgate, Baltimore Co., Md..........................	Jun. Assoc. M. M.	Feb. 3, 1903 Feb. 7, 1906 June 30, 1910
Whittier, Thomas Tupper. Asst. Engr. for George F. Hardy, 309 Broadway, New York City............		May 31, 1910
Wolff, Louis Peter. Cons. Engr., 204 Essex Bldg., St. Paul, Minn.....................................		June 30, 1910
Wright, John Bertram. Deputy Div. Engr., Second Div., New York State Highway Comm., 8 McClellan Ave., Amsterdam, N. Y................................	Assoc. M. M.	May 1, 1907 May 31, 1910

ASSOCIATE MEMBERS

Ayer, Frederic Eugene. Asst. Prof., Civ. Eng. Dept., Univ. of Cincinnati, Cincinnati, Ohio....................		May 31, 1910
Bentley, John Clark. Asst. Engr., N. Y., O. & W. Ry., Middletown, N. Y................................		May 31, 1910
Blanchard, Arthur Clarence Douglas. Asst. to City Engr., Toronto, Ont., Canada.........................		April 5, 1910
Bourguignon, Joseph. 236 State St., Flushing, N. Y....		May 31, 1910
Bruntlett, Eugene Harry. Engr., Security Bridge Co. (Res., 2453 Garfield Ave.), Minneapolis, Minn....................	Jun. Assoc. M.	June 6, 1905 June 30, 1910
Burroughs, Frederic. Asst. Supt., Filtration Div., Bureau of Water, 621 North St. Clair St., Pittsburg, Pa...............	Jun. Assoc. M.	June 4, 1907 May 3, 1910
Chase, Frank David. 1655 E. 55th St., Chicago, Ill....		June 30, 1910
Cook, Horace Arthur. Pres., Phœnix Eng. Co., 31 West Adams St., Phœnix, Ariz............................		May 3, 1910

ASSOCIATE MEMBERS (*Continued*).

		Date of Membership.
CORNELL, JOHN WESLEY. Asst. Div. Engr. of Tunnels, Board of Superv. Engrs. of Chicago; Address, 6949 Sheridan Rd., Chicago, Ill.		June 30, 1910
COUCHOT, GEORGE JOHN. Chf. Draftsman, Bond Issue Dept., City Engr.'s Office; Address, 1841 Green St., San Francisco, Cal.		May 3, 1910
COYNE, HARRY LEWIS. Asst. Engr., Public Service Comm. for First Dist., 509 West 146th St., New York City	Jun. Assoc. M.	Feb. 5, 1907 June 30, 1910
CROWE, FRANCIS TRENHOLM. With U. S. Reclamation Service, Boise, Idaho		May 3, 1910
CURRIER, ALBERT MOORE. Office Engr., Constr. Dept., L. S. & M. S. Ry.; Address, 7711 Lexington Ave., Cleveland, Ohio		May 3, 1910
DEMOREST, GEORGE MYRON. Engr., Canton Plant, American Bridge Co., Canton, Ohio		June 30, 1910
DUNCAN, DORSEY BERRY. City Engr., 204 Price Ave., Columbia, Mo.		May 31, 1910
DYGERT, HARRY ISAIAH. 2623 Ashby Ave., South Berkeley, Cal.		May 3, 1910
EDWARDS, DEAN GRAY. Asst. Engr., New York Board of Water Supply, Walden, N. Y.	Jun. Assoc. M.	Nov. 1, 1904 Feb. 1, 1910
ENSEY, RICHARD FAHNESTOCK. County Engr., Putnam County, Palatka, Fla.		April 5, 1910
FITZPATRICK, JAMES RAYMOND. Gen Mgr., Grand Rapids Hydr. Co.; Address, 90 N. Ottawa St., Grand Rapids, Mich.		May 31, 1910
FORD, HOWARD CARLTON. Asst. Prof. of Irrigation Eng. and Surv., Iowa State Coll., Ames, Iowa	Jun. Assoc. M.	Sept. 1, 1908 May 31, 1910
GARVER, NEAL BRYANT. 838 Forsythe St., Toledo, Ohio.		May 3, 1910
GAUMER, ALBERT WESLEY. Acting Chf. Engr., Juragua Iron Co., Firmeza, Santiago de Cuba		May 31, 1910
GEHRING, HERBERT AUGUST. Care, Highway Comm. of San Diego County, Room 406 Scripps Bldg., San Diego, Cal.		May 3, 1910
GOODMAN, LEON. Engr., Goodman-McCormick Co., 519 Utica Bldg., Des Moines, Iowa		June 30, 1910
GORTON, WILLARD LIVERMORE. Asst. Constr. Supt., Idaho Irrig. Co.'s Project, for J. G. White & Co., New York City; Address, Richfield, Idaho		May 3, 1910
GRANT, JOSEPH ALEXANDER. Gen. Mgr. and Member of Firm, Clinton Fireproofing Co. of Canada, Ltd., Eastern Townships Bank Bldg., Montreal, Que., Canada.		May 31, 1910

ASSOCIATE MEMBERS (*Continued*).

		Date of Membership.
Green, Theodore. Mgr., Chicago Office, Ferro-Concrete Constr. Co. of Cincinnati, 1326 Stock Exchange Bldg., Chicago, Ill		Mar. 1, 1910
Groat, Benjamin Feland. Care, Long Sault Development Co., Massena, N. Y		May 3, 1910
Hall, Hubert Harry. First Asst. Engr., Standard Oil Co., 461 Market St., San Francisco, Cal	Jun. Assoc. M.	April 30, 1907 May 3, 1910
Hall, Robert Elliot. (Aldrich & Hall), Room D, Seward Bldg., Auburn, N. Y	Jun. Assoc. M.	Sept. 6, 1904 June 30, 1910
Harris, Archie Lee. Asst. Engr., U. S. Reclamation Service, 421 Fleming Bldg., Phœnix, Ariz		May 31, 1910
Hastings, Edgar Morton. Res. Engr., Richmond, Fredericksburg & Potomac R. R., Byrd St. Station, Richmond, Va		June 30, 1910
Hayes, Charles Edward. Supt. of Constr., U. S. Reclamation Service, Babb, Mont	Jun. Assoc. M.	Mar. 6, 1906 May 31, 1910
Hilts, Harold Ezra. Asst. Engr., N. Y. C. & H. R. R. R., North Ave., New Rochelle, N. Y		May 31, 1910
Howe, Walter Clark. Supt. of Streets, City Hall, Oakland, Cal		May 31, 1910
Jones, Robert Sharp. Care, James Westwater & Co., 501 Wyandotte Bldg., Columbus, Ohio		June 30, 1910
Keator, Edward Orris. Room 515, Y. M. C. A. Bldg., Spokane, Wash		May 31, 1910
Kinsey, William Ambrose. Contr. Engr., 192 Market St., Newark, N. J		May 31, 1910
Koon, Joseph Burr. Gen. Mgr., Empire Car Co., 2524 Thirty-eighth St., Chicago, Ill		May 3, 1910
Krone, Arnold Henry. Director and in Chg., Eng. Dept. of J. Henry Miller, Inc., 106 Dover St., Baltimore, Md.		May 31, 1910
Lamb, William Alfred. Asst. Engr., Water Resources, U. S. Geological Survey, Helena, Mont	Jun. Assoc. M.	Nov. 5, 1907 May 3, 1910
Law, Walter Hills. Asst. Engr., with Congress St. Bridge Comm.; Address, 38 Sterling St., Bridgeport, Conn		May 31, 1910
Lawton, Richard Mack. Office Asst. to Terminal Engr., N. Y. C. & H. R. R. R., 335 Madison Ave., New York City		May 3, 1910
Layng, Frank Rahn Shunk. Engr. of Track, Bessemer & Lake Erie R. R., Greenville, Pa	Jun. Assoc. M.	April 1, 1902 May 3, 1910
Lockwood, Richard John. Chf. Engr., New Iberia & Northern R. R. Co., New Iberia, La		May 3, 1910

ASSOCIATE MEMBERS (*Continued*).

		Date of Membership.
Lush, Cuyler Warfield. Village Engr., P. O. Box 722, Rye, N. Y.	Jun. Assoc. M.	Feb. 4, 1908 May 31, 1910
McMenimen, William Vincent. 172 Fairview Ave., Jersey City, N. J.	Jun. Assoc. M.	April 30, 1907 May 31, 1910
McNary, Joseph Vance. Asst. Engr., Div. of Bridges, Bureau of Constr., Dept. of Public Works, 718 Berkshire Ave., Pittsburg, Pa.		June 30, 1910
Means, Howard Chester. Supt. of Irrig., U. S. Indian Service, Ft. Duchesne, Utah		June 30, 1910
Metzger, Louis Charles Frederick. Asst. Engr., Terminal R. R. Association of St. Louis, 2650 Accomac St., St. Louis, Mo.		May 31, 1910
Miller, Walter Edward. Asst. Engr., R. R. Comm. of Wisconsin, Madison, Wis.		May 31, 1910
Minor, Cyrus Edward. Asst. Engr., Cananea Consolidated Copper Co., Box 150, Cananea, Sonora, Mexico		May 31, 1910
Moorshead, Oliver. Chf. Engr., Central Kansas Interurban Ry. Co.; Address, 311 West Broadway, Newton, Kans.		May 31, 1910
Morgan, Arthur Ernest. (Morgan Eng. Co.), 612 Goodwyn Inst. Bldg., Memphis, Tenn.		May 3, 1910
Nagel, John. Supt., Manhattan Beach Estates, Manhattan Beach, N. Y.		June 30, 1910
O'Brien, Daniel Bernard. Engr., O'Brien & Hoolihan Constr. Co., 1722 Park St., Syracuse, N. Y.	Jun. Assoc. M.	April 3, 1906 May 3, 1910
Parker, James Lafayette. Prin. Asst. to Herbert C. Keith, 116 Nassau St., Room 901, New York City	Jun. Assoc. M.	April 2, 1907 May 3, 1910
Peabody, Lionel Henry, Jr. Associate with O. Perry Sarle, 146 Westminster St., Providence, R. I.	Jun. Assoc. M.	Feb. 6, 1906 Jan. 4, 1910
Peters, Frederic Hatheway. With Dept. of Interior, Canada, P. O. Drawer V, Calgary, Alta., Canada		June 30, 1910
Philbrook, Lee Elmo. With E. C. & R. M. Shankland, 1106 The Rookery, Chicago, Ill.		May 3, 1910
Quimby, John Herman. 11 North 18th St., East Orange, N. J.		April 5, 1910
Rice, Guy Wickliffe. Chf. Engr., Oregon Val. Land Co. and Lakeview Irrig. & Power Co., Lakeview, Ore.		May 3, 1910
Rich, Melvin S. 1448 Harvard St., Washington, D. C.	Jun. Assoc. M.	Sept. 5, 1905 May 31, 1910
Rights, Herbert Timothy. Hilldale Rd., Lansdowne, Pa.		April 5, 1910
Ritter, Rollin. Engr., U. S. Indian Irrig. Service, Black Rock, N. Mex.		May 31, 1910

ASSOCIATE MEMBERS (*Continued*).

		Date of Membership.
SAUCEDO, VICENTE. Res. Engr., Monterey Water Works and Sewer System, P. O. Box 291, Monterey, N. L., Mexico	Jun. Assoc. M.	Oct. 6, 1903 May 3, 1910
SAUNDERS, HENRY JENNINGS. Res. Engr., The Arnold Co.; Address, Valier, Mont		May 3, 1910
SAWYER, PERCY. Mgr., Waukesha Block & Material Co., Waukesha, Wis	Jun. Assoc. M.	Oct. 2, 1906 Jan. 4, 1910
SCHUYLER, PHILIP. With Stephen E. Kieffer, First National Bank Bldg., Berkeley, Cal		May 31, 1910
SIKES, ZENAS HARRISON. Asst. Engr., Structural Dept., N. Y. C. & H. R. R. R., 333 Riverdale Ave., Yonkers, N. Y		June 30, 1910
SMITH, ELIOT NICHOLS. Board of Water Supply, Poughkeepsie, N. Y	Jun. Assoc. M.	April 2, 1907 June 30, 1910
SMITH, KARL GARTHWAITE. Contr. Engr., 857 Broad St., Newark, N. J		May 3, 1910
STANSBURY, HERBERT EARL. Asst. Engr., El Paso & Southwestern R. R., Box 675, Tucumcori, N. Mex		May 3, 1910
STANTON, WILBOR DICKENS. With Isthmian Canal Comm., Dept. of Eng., Las Cascadas, Canal Zone, Panama	Jun. Assoc. M.	Oct. 2, 1906 May 3, 1910
STEVENS, HAROLD CONVERSE. Asst. Engr. Designer, Board of Water Supply, 165 Broadway, New York City		June 30, 1910
STRICKLER, THOMAS JOHNSON. 2611 Forest Ave., Kansas City, Mo		May 3, 1910
STURGEON, GEORGE BLAIR. Supt. of Constr., Doe Library, Univ. of California, Berkeley, Cal		May 31, 1910
TERRY, ARTHUR LINVILLE, JR. Secy. and Treas. (Hungerford & Terry), 1414 Pennsylvania Bldg., Philadelphia Pa	Jun. Assoc. M.	Mar. 5, 1907 June 30, 1910
TOMBO, CARL. Box 30, Station J, New York City	Jun. Assoc. M.	Feb. 3, 1903 Jan. 4, 1910
TREADWELL, WILLIAM ADAMS. Box 143, St. Johnsville, N. Y	Jun. Assoc. M.	April 4, 1905 Feb. 1, 1910
TRUE, ALBERT OTIS. Care, State Dept. of Health, Albany, N. Y	Jun. Assoc. M.	Feb. 5, 1907 May 31, 1910
WARD, WALTER. Care, U. S. Reclamation Service, Boise, Idaho		May 3, 1910
WEINSTOCK, HARRY HERSCHEL. Asst. Engr., Eng. Constr. Dept., Pres. of the Borough of Richmond (Res., 60 West 119th St.), New York City		June 30, 1910
WEMLINGER, JULIUS RALPH. Pres., Wemlinger Steel Piling Co., 11 Broadway, New York City		Nov. 8, 1909
WHITAKER, RALPH WALLACE. Prin. Asst. Engr., Vera Cruz Terminal Co., Ltd., Avenida Independencia No. 2, Vera Cruz, Mexico		April 5, 1910

ASSOCIATE MEMBERS (*Continued*).

		Date of Membership.
Williams, Le Roy Duncan. County Surv., Macon County, Macon, Mo.............	Jun. Assoc. M.	Feb. 5, 1907 May 31, 1910
Work, Joe Young. Care, Elks Club, Denver, Colo........		May 3, 1910

ASSOCIATES

Belzner, Theodore. Insp. of Steel, Dept. of Bridges, Manhattan Borough (Res., 614 West 135th St.), New York City...............	Jun. Assoc.	Oct. 5, 1897 May 3, 1910
Brown, Joseph Henry, Jr. In Chg. of Estimating Dept., Sullivan Machinery Co. of Chicago, 30 Church St., New York City................................		June 30, 1910
Kenyon, William John Charles. Vice-Pres. and Gen. Mgr., George W. Jackson, Inc.; Address, 31 East Division St., Chicago, Ill.......................		May 31, 1910

JUNIORS

Ackerman, Arthur Pope. Care, Board of Water Supply of New York City, Vail Gate, N. Y..............	June 30, 1910
Banta, Russell Vincent. Designer, Reinforced Concrete, Hennebique Constr. Co. of New York; Address, 11 Washington Pl., Ridgewood, N. J.................	May 31, 1910
Barney, William Joshua. Secy., Dept. of Docks and Ferries, Pier A, North River, New York City......	April 5, 1910
Bell, Howard Fred. Asst. Engr. in Chg. of Constr. of Sewerage System, Jefferson, Ohio.................	May 31, 1910
Bolton, Frank Leonard. 34 Clinton Ave., North, Rochester, N. Y................................	June 30, 1910
Buchanan, Nathan Booker. Asst. Res. Engr., Corey Land Co., 2024 Third Ave., Birmingham, Ala......	Mar. 1, 1910
Buettner, Otto George Henry. Care, Interborough Rap. Transit Co., 32 Park Pl., New York City..........	May 31, 1910
Calkins, Charles Dow. Instr., Math. and Surv., Rensselaer Pol. Inst., and Draftsman for City of Troy, 23 Thirteenth St., Troy, N. Y....................	April 5, 1910
Cefalu, Frank Dominic. Surv., U. S. Army Engrs., Burrwood, La.................................	April 5, 1910
Craven, Jay Allen. Care, Florence Pumping Station, Florence, Nebr................................	May 31, 1910
Croasdale, Laurence Brodhead. 725 E. Washington St., Phœnix, Ariz.................................	May 31, 1910
Dittoe, William Henry. Eng. Dept., Ohio State Board of Health, Columbus, Ohio......................	May 3, 1910
Emigh, William Chester. North Adams, Mass.........	May 31, 1910
Ferris, Raymond West. 909 Harrison Bldg., Columbus, Ohio..	May 3, 1910

JUNIORS (*Continued*).

	Date of Membership.
Forbes, Francis Bonner. 8 West 56th St., New York City	May 3, 1910
Gard, Hermon Yancy. 1729 South 20th St., St. Joseph, Mo	Jan. 4, 1910
Glander, John Henry, Jr. Asst. on Garden City Development with Charles W. Leavitt, Jr., 220 Broadway, New York City	May 3, 1910
Hadley, Homer More. Care, Katalla Co., Mile 125, Copper River & Northwestern Ry., Cordova, Alaska	April 5, 1910
Hall, Charles Lacey. 2d Lieut., Corps of Engrs., U. S. A., Washington Barracks, D. C	June 30, 1910
Hall, Joseph Emmett. Pres., J. E. Hall Co., 839 Lemcke Bldg., Indianapolis, Ind	June 30, 1910
Halsey, Milo Clinton. Box 587, Monrovia, Cal	June 30, 1910
Hammel, Edward Frederic. 610 North 3d St., Harrisburg, Pa	Feb. 1, 1910
Henes, Harry William. 557 Barry Ave., Chicago, Ill	May 31, 1910
Hirsch, John George. Asst. Engr. with D. W. Mead; Address, 118 West Dayton St., Madison, Wis	June 30, 1910
Holloway, Roger Tifft. Cons. Engr. (Mead & Holloway), 1170 Broadway, New York City	May 31, 1910
Holmes, Thomas Hughes. Steel Insp., C. & N. W. Ry., 215 Jackson Blvd., Room 804, Chicago, Ill	Jan. 4, 1910
Jones, Ralph Henry. 653 West 81st St., Seattle, Wash	Jan. 4, 1910
Leach, Thomas. 3 Lilac St., Buffalo, N. Y	June 30, 1910
Leonard, Edward Philip. 898 Gates Ave., Brooklyn, N. Y.	May 3, 1910
Letton, Harry Pike. (Grant & Letton), 401 F. & M. Bldg., Lincoln, Nebr	Feb. 1, 1910
Lincoln, Edward Lewis. Y. M. C. A., White Plains, N. Y	May 3, 1910
McWethy, Le Roy. 1262 Flood Bldg., San Francisco, Cal	Jan. 4, 1910
Muchemore, Harrie Langdon. Expert Aid, Office of Insp. of Public Works, Navy Yard, New York City; Address, 119 Murray St., Elizabeth, N. J	Mar. 1, 1910
O'Reilly, Francis Sheridan. Care, Degnon Contr. Co., Sandwich, Mass	Jan. 4, 1910
Reese, George Washington. U. S. Junior Engr., Care, U. S. Engr. Office, Vicksburg, Miss	May 31, 1910
Rhodes, Glenn Vernon. Junior Asst. Engr., Board of Public Works, 152 Twelfth Ave., San Francisco, Cal	May 3, 1910
Roberts, Richard Francis. Draftsman, Bridge Dept., N. Y., N. H. & H. R. R., Room 314, Railroad Bldg., New Haven, Conn	May 31, 1910

JUNIORS (*Continued*).

	Date of Membership.
Shapleigh, Charles Henry. Chf. Engr., River, Rail & Harbor Constr. Co., 739 North State St., Jackson, Miss.	June 30, 1910
Soest, Hugo Conrad. Care, Interborough Rap. Transit Co., 32 Park Pl., New York City	May 31, 1910
Taylor, George Blaney. P. O. Box 804, New Britain, Conn	May 3, 1910
Terry, Francis Marion. Designing Engr. and Supt. of Constr., H. L. Stevens & Co., Oklahoma City, Okla.	June 30, 1910
Toms, Jay William. 3814 Westminster Pl., St. Louis, Mo	Nov. 30, 1909
Trelease, Frank Johnson. Care, The Missouri Botanical Garden, St. Louis, Mo	May 3, 1910
Whittemore, Leslie Clifford. Asst. Engr., Board of Water Supply of New York City, 236 Main St., Poughkeepsie, N. Y	May 3, 1910
Wilder, Ellwood Coggeshall. 7 West 106th St., New York City	June 30, 1910
Wilson, Rodney Melledge. 123 Woodland Ave., New Rochelle, N. Y	May 31, 1910

CHANGES OF ADDRESS

MEMBERS

Alden, Herbert Clarendon. Asst. Engr., Bureau of Sewers, Borough of the Bronx, 1518 Purdy St., New York City.

Allen, Walter Hinds. Civ. Engr., U. S. N., Bureau of Yards and Docks, Navy Dept., Washington, D. C.

Anderson, David Guy. Cons. Engr., 4032 Walnut St., Philadelphia, Pa.

Aycrigg, William Anderson. Cons. Engr., R. F. D. No. 1, Waterford, Conn.

Baker, William Edgar. 105 West 40th St., New York City.

Ball, Charles Backus. Chf. San. Insp., Dept. of Health, 215 Madison St. (Res., 1951 Sunnyside Ave.), Chicago, Ill.

Bayliss, John Yancey. Care, Madeira-Mamoré Ry. Co., Caixa 304, Manaos, Brazil.

Beardsley, James Wallace. With J. G. White & Co., Inc., San Juan, Porto Rico.

Belden, Harry Austin. Care, Capital Traction Co., Washington, D. C.

Bent, Cornelius Conway Felton. Care, Staten Island R. R., 17 State St., New York City.

Biddle, William Foster. Care, H. S. Drinker, South Bethlehem, Pa.

Bixby, William Herbert. Col., Corps of Engrs., U. S. A., 508 Colorado Bldg., Washington, D. C.

Bloom, J George. Pres., Southern Ballast Co., Mill Creek, Okla.

MEMBERS (*Continued*).

BOGUE, VIRGIL GAY. 15 William St., New York City.

BREUCHAUD, JULES. (Jules Breuchaud Constr. Co.), 290 Broadway (Res., The Belnord, Broadway and 86th St.), New York City.

BROWN, WENDELL PHILLIPS. Contr. Engr., King Bridge Co., Cleveland, Ohio.

BUCK, HENRY ROBINSON. (Buck & Sheldon, Inc.), San. and Structural Engrs., 60 Prospect St., Hartford, Conn.

BURDETT, FREDERICK ANDERSON. Cons. Engr., 16 East 33d St., New York City.

BURR, EDWARD. Lt.-Col., Corps of Engrs., U. S. A., Office of Chf. Engr., U. S. A., Washington, D. C.

CASE, JAMES FRANCIS. Apartado 669, Havana, Cuba.

CHAMBERS, FRANK TAYLOR. Civ. Engr., U. S. N., Navy Yard, Norfolk, Va.

COLE, DANIEL WEBSTER. Project Engr., U. S. Reclamation Service, Fallon, Nev.

COMSTOCK, CHARLES WORTHINGTON. State Engr., Boston Bldg., Denver, Colo.

CREHORE, WILLIAM WILLIAMS. Cons. Engr., 30 Church St., Room 708, New York City.

CROSWELL, THOMAS HENRY. Chf. Engr., Spokane, Portland & Seattle Ry., and Astoria & Columbia River Ry.; Address, East 8 Hill Ave., Spokane, Wash.

CRUMP, RALPH LEE. Care, Ford, Bacon & Davis, L. & L. & G. Bldg., New Orleans, La.

DARLING, FRED STEERE. Care, Toronto Constr. Co., 14 Wellington St., East, Toronto, Ont., Canada.

DAVIS, CHARLES E. L. B. Brig-Gen., U. S. A. (*Retired*), 726 Chronicle Bldg., San Francisco, Cal.

DODGE, JAMES LYNN. Care, Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City.

DOUGLAS, WALTER JULES. Care, William Barclay Parsons, Cons. Engr., 60 Wall St., New York City.

ELLIS, GEORGE EZRA. Vice-Pres., Hayes Track Appliance Co., Y. M. C. A. Bldg., Geneva, N. Y.

ENDO, TOKICHI. Engr., M. of W. and Works Section, Imperial Govt. Rys., Tokyo, Japan.

FERGUSON, JOHN NEIL. Asst. Engr., Board of Harbor and Land Commrs., Room 131, State House, Boston, Mass.

FISH, JOHN CHARLES LOUNSBURY. Berlin Heights, Erie Co., Ohio.

FLINN, ALFRED DOUGLAS. Dept. Engr., Board of Water Supply, 165 Broadway, New York City.

FRAZIER, JAMES LEWIS. Cons. Engr., 808 Columbia Bldg., Louisville, Ky.

FRAZIER, JAMES WELCH. (The J. W. Frazier Co.), Rockefeller Bldg., Cleveland, Ohio.

FROSELL, CARL GUSTAF. 523 Jeanette St., Wilkinsburg, Pa.

GOODRICH, ERNEST PAYSON. Cons. Engr., 2 Rector St., New York City.

MEMBERS (*Continued*).

GOODWIN, GEORGE ESTYN. Civ. and Constr. Engr., Sisters, Ore.

GOODWIN, JAMES BOWMAN. 50 Windsor Ave., Montreal, Que., Canada.

GRIFFIN, WILLIAM REID WESLEY. Care, The East Liverpool Traction & Light Co., East Liverpool, Ohio.

HADSALL, HARRY HUGH. Gen. Supt., Leonard Constr. Co., Room 1937, McCormick Bldg., Chicago, Ill.

HALL, BENJAMIN MORTIMER. Atlanta, Ga.

HALL, JOHN LINCOLN. Second Vice-Pres., Purdy & Henderson, 1142 Henry Bldg., Seattle, Wash.

HARDY, HARRY. Cristobal, Canal Zone, Panama.

HAWXHURST, ROBERT, JR. Cons. Engr. (Hawxhurst & Wolf), 623 Salisbury House, London, E. C., England.

HAYES, EDWARD. Cons. Engr., P. O. Box 459, Fairport, N. Y.

HIMMELWRIGHT, ABRAHAM LINCOLN ARTMAN. Cons. and Superv. Engr., N. E. Cor. of 23d St. and 6th Ave., New York City.

HODGES, GILBERT. Cons. Engr., Hill, N. H.

HOWE, HORACE JOSEPH. Asst. Engr., Public Service Comm., 231 West 125th St., New York City.

HOWELL, JULIUS MERRIAM. Hydr. Engr., Belvedere, Marin Co., Cal.

JANNEY, WILLIAM DEAN. 2109 Homewood Ave., Baltimore, Md.

JAYCOX, THOMAS WILLIAM. Cons. Civ. Engr., 1608 Broadway, Denver, Colo.

KATTE, WALTER. Care, E. B. Katte, Barney Park, Irvington-on-Hudson, N. Y.

KNIGHTON, JOHN ALBERT. Asst. Engr., Dept. of Bridges, New York City; Engr. in Chg., Queensboro Bridge, 305 East 60th St., New York City.

LEE, FRANCIS VALENTINE TOLDERVY. Asst. Gen. Mgr. and Chairman, Eng. Committee, Pacific Gas & Elec. Co. and San Francisco Gas & Elec. Co., San Francisco, Cal.; Address, Care, Inst. of Electrical Engrs., Victoria Embankment, London, England.

LEONARD, JAMES AUGUSTUS. Chf. Engr., Blue Earth Dam, Rapidan, Minn.

LOCKWOOD, JUDD ALLEN. Asst. Engr., Dept. of Bridges; Address, 501 West 145th St., New York City.

LYNCH, MICHAEL LEHANE. 418 North St., Jackson, Miss.

McKAY, GEORGE ALBERT. Civ. Engr., U. S. N., U. S. Navy Yard, Mare Island, Cal.

McREYNOLDS, ORVAL OMAR. Cons. Civ. and Min. Engr., Maricopa, Kern Co., Cal.

MALTBY, FRANK BIERCE. 109½ Lexington Ave., Syracuse, N. Y.

MEANS, THOMAS HERBERT. Agri. Engr. (Symmes & Means), Balboa Bldg., San Francisco, Cal.

MILES, JOHN WILEY. Care, American Club, Mexico, D. F., Mexico.

MILLS, ARTHUR LORENZO. Pres., Peat Industry Co., Apartado 123 Bis, City of Mexico, Mexico.

MEMBERS (*Continued*).

MILLS, CHARLES MALON. Cons. Engr., The E. E. Smith Contr. Co., 71 Broadway, Room 415, New York City.

MORRIS, MARSHALL, JR. With H. L. Stevens & Co., P. O. Box 1129, El Paso, Tex.

MÜLLER, EJNAR JÖNSBERG. Cons. Engr., 17 Museum Rd., Shanghai, China.

MURPHY, EDWARD CHARLES. Engr., U. S. Geological Survey, 2503 Elsworth St., Berkeley, Cal.

NOSTRAND, PETER ELBERT. Cons. Engr. and City Surv., 7 Beekman St., New York City.

OLMSTED, ASHBEL EDWARD. 841 St. Nicholas Ave., New York City.

PAGE, WILLIAM NELSON. Ansted, W. Va.

PARSONS, ROBERT STEVENS. Care, Erie R. R., Jersey City, N. J.

PEIMBERT, ANGEL. Res. Engr., S. Pearson & Son, Ltd., 4a Humboldt No. 31, City of Mexico, Mexico.

PURDON, CHARLES DE LA CHEROIS. Chf. Engr., St. L. & Southwestern Ry. Co., St. Louis, Mo.

PUTNAM, GEORGE ROCKWELL. Light-House Bureau, Washington, D. C.

RICH, EDWARD DUNBAR. 521 Board of Trade Bldg., Indianapolis, Ind.

RITTER, LOUIS E. (Ritter & Mott), 1707 Marquette Bldg., Chicago, Ill.

ROBERTS, SHELBY SAUFLEY. 1454 Second St., Station E, Louisville, Ky.

ROURKE, LOUIS KEEGAN. Supt. of Streets, Room 47 City Hall, Boston, Mass.

RUSSELL, SILAS BENT. Cons. Civ. Engr., 4950 Washington Ave., St. Louis, Mo.

SAFFORD, HARRY ROBINSON. Care, Edgar Allen Am. Manganese Steel Co., 193 Michigan Ave., Chicago, Ill.

SNOW, JESSE BAKER. Care, The Foundation Co., P. O. Box 866, Helena, Mont.

STREET, LEONARD LEE. Civ. Engr. and Contr., 83 Tonawanda St., Dorchester, Mass.

SUTER, CHARLES RUSSELL. Brig.-Gen., U. S. A. (*Retired*), Roxbury, Delaware Co., N. Y.

TAYLOR, WILLIAM GAVIN. Deputy Chf. Engr., Passaic Val. Sewerage Commrs., 92 Park Pl., Newark, N. J.

THOMPSON, FRED. Civ. Engr., U. S. N., U. S. Naval Station, San Juan, Porto Rico.

TOMLINSON, SAM. N. High St., Singapore, Straits Settlements.

TYE, WILLIAM FRANCIS. Cons. Engr., 7 King St., East, Toronto, Ont., Canada.

VINCENT, EDWIN DERICKSON. Care, City Engr.'s Office, Los Angeles, Cal.

WADSWORTH, GEORGE REED. Care, The Peerless Motor Car Co., Cleveland, Ohio.

WALMSLEY, WALTER NEWBOLD. Care, Sao Paulo Tramway, Light & Power Co., Ltd., Sao Paulo, Brazil.

WATSON, WILLIAM PARSONS. Room 414 Crary Bldg., Seattle, Wash.

MEMBERS (*Continued*).

WEGMANN, EDWARD. Chf. Engr., Aqueduct Commrs., 13 Park Row, Room 2332, New York City.

WENZELL, ANDREW JACKSON. Cons. Engr., 171 Stanton Ave., Detroit, Mich.

WICKES, EDWARD DANA. Marion, Mass.

WITT, CARLTON CARPENTER. Engr., South Dakota R. R. Comm., Pierre, S. Dak.

WRIGHT, JOSEPH. Engr., U. S. Reclamation Service, St. Ignatius, Mont.

WRIGHT, PARKER O., JR. 422 Security Bldg., Los Angeles, Cal.

ZOOK, MORRIS ALEXANDER. Civ. and Cons. Engr., Room 463 Grand Central Station, Chicago, Ill. (Res., 123 East 6th St., Plainfield, N. J.)

ASSOCIATE MEMBERS

AGRAMONTE, ALBERT ARTHUR. Direccion Desagues Obras Accessorias, Dolores, F. C. Sud, Buenos Aires, Argentine Republic.

ALEXANDER, KAY. Asst. Engr., N. P. Ry., Elbowoods, N. Dak.

ALLEN, EUGENE YORKE. Office Engr., R. R. and Canal Revaluation, State of New Jersey, 55 Broad St., Elizabeth, N. J.

ALSBERG, JULIUS. Care, John Bogart, 141 Broadway, New York City.

BALDWIN, GEORGE HERBERT. 2632 Channing Way, Berkeley, Cal.

BASSETT, ROBERT JAY. 1631 East 9th St., Brooklyn, N. Y.

BEACH, WILLIAM NICHOLAS. Care, Pennsylvania Cement Co., 29 Broadway, New York City.

BERRY, FRANCIS RIGDON. Care, Butler Water Co., 112 East Jefferson St., Butler, Pa.

BLACK, RALPH PETERS. Engr., M. of W., Kanawha & Mich. Ry., Charleston, W. Va.

BLANCHARD, MURRAY. 730 North Lefferts Ave., Richmond Hill, N. Y.

BOLTZ, THOMAS FRANKLIN. Asst. Engr. and Supt. of Constr., Pacific & Eastern Ry., Medford, Ore.

BOND, JUDSON BAKER. Care, Conrad Land & Water Co., Ft. Shaw, Mont.

BRINKLEY, MILO HAMILTON. Asst. Engr., G. N. Ry., Wellington, Wash.

BULLEN, ROY. Logan, Utah.

BURWELL, ROBERT LEMMON. Asst. Engr., Baltimore Sewerage Comm., Storm Water Div., 1405 Park Ave., Baltimore, Md.

CAMPBELL, DUNCAN HUGH. Locating Engr., C. M. & P. S. Ry., Care, Gen. Delivery, Great Falls, Mont.

CHARLES, LAVERN JOHN. Care, U. S. Reclamation Service Storage Unit, 14 South 8th St., North Yakima, Wash.

COBB, STEPHEN PRENTIS. Care, Albany Southern R. R. Co., Albany, N. Y.

COLLINS, FRANK JOSEPH. Supt., Stewart-Kerbaugh-Shanley Co., 410 Dake Bldg., Rochester, N. Y.

CONNER, RALPH MELVIN. 17 Hutchinson St., Winthrop, Mass.

COREY, RAY HOWARD. 521 Beck Bldg., Portland, Ore.

COULTER, WALDO SCARLETTE. 1117 Glenwood Rd., Brooklyn, N. Y.

ASSOCIATE MEMBERS (*Continued*).

CRAIG, JOSEPH EDWIN. Cons. Engr. (Craig & Marshall), Box 181, Green Cove Springs, Fla.

CREELMAN, CHARLES LAUDER. 204 Savage-Scofield Bldg., Tacoma, Wash.

CURTIS, LOREN BRADLEY. 710 Kittredge Bldg., Denver, Colo.

DAVIS, BENJAMIN HERMAN. Cons. Engr., 1 Madison Ave., New York City.

DAVIS, JAMES LYFORD. Asst. Engr., Board of Water Supply, City of New York, Bryn Mawr Park, Yonkers, N. Y.

EDWARDS, CHARLES MILTON. First Asst. Engr., New York State Dept. of Highways, Kirstein Bldg., Rochester, N. Y.

ELLIOTT, JOHN STUART. Civ. and Min. Engr., 29 Broadway, New York City.

ENGLE, CHARLES ALGERNON. Engr., Great Shoshone & Twin Falls Power Co., Hollister, Idaho.

EVANS, JOHN EDWARD. Asst. Engr., Detroit River Tunnel Co., 413 Maple St., Ypsilanti, Mich.

FRENCH, CHARLES RAUCH. 1399 Wyoming Ave., Forty Fort, Pa.

FROST, GEORGE SHERMAN. Asst. Engr., Public Service Comm. for the First Dist., State of New York, 23 Flatbush Ave., Brooklyn, N. Y.

GARMAN, HARRY OTTO. Associate Prof. of Civ. Eng., Purdue Univ.; Address, 739 Owen St., Lafayette, Ind.

GREEN, ANDREW H. Canefield, Dominica, B. W. I.

GREEN, JAMES COWAN. 860 Myrtle Ave., Albany, N. Y.

GREENE, CARLETON, Cons. Engr. (Greene & Greene), 11 Broadway, New York City.

GUNDERSEN, AUGUST. Care, A/s Hoyer Ellefsen, Toldbodgoden 30, Christiania, Norway.

HAAS, PHILIP LIPPMAN. State Road Engr., Care, Div. Engr.'s Office, State Dept. of Highways, Poughkeepsie, N. Y.

HASKELL, FRANK HAMPTON. Div. Engr., M. of W., C. & O. R. R., General Offices, Covington, Ky.

HATTAN, WILLIAM CARY. Care, Carter Constr. Co., Meyersdale, Pa.

HENDERSON, SAMUEL WHILDEN. Mgr., The Excelsior Springs Light, Power, Heat & Water Co., The Excelsior Water Co., The Marysville Light, Power & Water Co., Excelsior Springs, Mo.

HIGHLEY, LEE. Chf. Engr., Pacific & Idaho Northern R. R., Weiser, Idaho.

HOOD, HUGH KENDALL. Smith's Station, Ala.

HUFF, CLYDE LESLIE. Care, City Engr., Salt Lake City, Utah.

HUNICKE, WILLIAM AUGUST. 2937 Henrietta St., St. Louis, Mo.

IRISH, LELAND WESLEY. 862 Myrtle Ave., Albany, N. Y.

JENKINS, JAMES EDGAR. 3440 Broadway, New York City.

JONES, WALTER ALPHEUS. Box 30, Weatherly, Pa.

KEIM, WARREN BYRON. Asst. Engr., Bridges and Constr. Dept., The Pennsylvania Steel Co., Steelton, Pa.; Address, Camp Hill, Pa.

KEMPKEY, AUGUSTUS, JR. 721 Balboa Bldg., San Francisco, Cal.

KING, EVERETT EDGAR. Bedford, Ind.

ASSOCIATE MEMBERS (*Continued*).

King, Roy Stevenson. Mech. Engr., Gary, Ind.

Laurgaard, Olaf. Chf. Engr., O. W. & I. F. Co., 504 Couch Bldg., Portland, Ore.

Leane, Walter Burditt. Chf. Engr., Ferrocarril Longitudinal, Seccion Norte, Agustinas 718, Santiago, Chili.

Leffler, Burton Rutherford. Engr. of Bridges, L. S. & M. S. Ry., Suite 3, The Chillon, Cleveland, Ohio.

Lobo, Carlos. Asst. Engr., Dept. of Water Supply, Gas and Electricity, 13 Park Row, Room 2015, New York City (Res., 550 Seventh St., Brooklyn, N. Y.).

Macartney, Morton. City Engr., Spokane, Wash.

McLure, Norman Roosevelt. 527 Pierce Bldg., St. Louis, Mo.

Manter, Ralph Barton. Chf. Engr., Ferrocarril del Cauca, Buenaventura, Colombia.

Melick, Neal Albert. Supt. of Constr., U. S. Public Bldgs., Davenport, Iowa.

Miller, Stanley Alfred. Care, Direccion General de Obras Publicas, Santo Domingo, Santo Domingo.

Moorehead, Theodore Parker. Vice-Pres., H. L. Stevens & Co., 640 New York Blk., Seattle, Wash.

Morrison, Charles Edward. 50 Pine St., New York City.

Morrow, Frederick Edgar. Field Engr., Board of Superv. Engrs., Chicago Traction, 423 North Central Ave., Chicago, Ill.

Mould, George Alexander Hutchings. With Snare & Triest Co., Tiburon, Cal.

Newhall, William Barrett. Cons. Engr., Raymondville, Tex.

Nolen, William Isaac. Care, Herzog Iron Works, 312 Chamber of Commerce Bldg., St. Paul, Minn.

Northrop, Albert Allen. Res. Engr., Holter Dam, Holter, Mont.

Patterson, Robert Youngman. Care, S. R. H. Robinson & Son Contr. Co., 915 Chemical Bldg., St. Louis, Mo.

Peterson, John. Asst. Engr. Designer, Board of Water Supply, 165 Broadway, Room 725, New York City.

Pond, Harry Bradford. Unionville, Conn.

Poole, John Hudson. 1004 Penobscot Bldg., Detroit, Mich.

Proctor, Ralph Fenno. P. O. Box 101, Canon City, Colo.

Ramsey, Guy Robert. Orlando, Fla.

Rhoades, Theodore Eckford. Chf. Engr., Whitney-Steen Co., 1 Liberty St., New York City.

Richardson, James Herbert. Care, Engr. of Structures, N. Y. C. & H. R. R. R., Boston, Mass.

Robinson, Reuben Totman. 316 Dayton St., Hamilton, Ohio.

Rockwood, Edward Farnum. Chf. Engr., New England Concrete Constr. Co., 201 Devonshire St., Boston, Mass.

Rue, Malcolm Asher. Care, Robert Wilson Co., 200 Fifth Ave., New York City.

ASSOCIATE MEMBERS (*Continued*).

RUNYON, WILLIAM KERPER. 18 West Kinney St., Newark, N. J.

SAMPLE, WILLIAM DWIGHT. Twisp, Wash.

SEVERSON, OSCAR MELVERN. Falconer, Chautauqua Co., N. Y.

SEYFERT, EDGAR ERNEST. 1902 Frick Bldg., Pittsburg, Pa.

SHAW, ARTHUR MONROE. Engr. and Res. Mgr., Phillips Land Co., 1678 Robert St., New Orleans, La.

SHELDON, PAUL. Secy. and Treas., Buck & Sheldon, Inc., 60 Prospect St., Hartford, Conn.

SHELLENBERGER, LEIDY RUDY. Asst. Engr. for Grand Central Station Archts., 19 East 42d St., Bayonne, N. J.

SHERTZER, TYRRELL BRADBURY. Eng. Draftsman, Public Service Comm. for First Dist., 565 Fifth Ave., Brooklyn, N. Y.

SISSON, GEORGE ARTHUR. Care, Newport Eng. Co., 235 Worcester Bldg., Portland, Ore.

SITT, WILLIAM THEODORE. Cons. Engr., Wells Bros. Co. of New York, 366 Fifth Ave., New York City.

SMILEY, GRIER RALSTON. Div. Engr., Florida East Coast Ry., Key West Extension, Key West, Fla.

STENGER, ERNEST. Gen. Supt., Ray Con. Copper Co., 124 G St., Salt Lake City, Utah.

STOCKMAN, LOUIS RICHARD. Care, The Laramie-Poudre Reservoirs & Irrig. Co.; Address, 820 West Olive St., Fort Collins, Colo.

STRONG, WILLIAM EDWARD SCHENCK. Mgr., Eng. Dept., Am. Radiator Co., 31 Nassau St., Room 1605, New York City.

SUTER, RUSSELL. Res. Engr., State Water Supply Comm., Albany, N. Y.

TAFT, JESSE RUSSELL. 157 West 80th St., New York City.

TARR, CHARLES WINTHROP. 10 Orange St., Brooklyn, N. Y.

TAYLOR, NORMAN ALFRED. Cons. Engr., Standard Oil Co., Baltimore, Md.

TURNER, AUGUSTUS MIESSE. 315 East 5th St., Mt. Carmel, Ill.

VERNON, STEPHEN BARKER. Intercepting Sewer Board, City Hall, Syracuse, N. Y.

WAGNER, FRED J. Chf. Engr., Scott Bros., P. O. Box 403, Rome, N. Y.

WALKER, EDWARD LLOYD. Care, Dept. of Water Supply, Gas and Electricity, Room 2332 Park Row Bldg., New York City.

WASSNER, MICHAEL. 18 South River St., Aurora, Ill.

WEIDNER, CARL ROBERT. Instr. in Hydr. Eng., Univ. of Wisconsin, 422 N. Henry St., Madison, Wis.

WENIGE, ARTHUR EMIL. Asst. Engr., Dept. of Water Supply, Borough of Brooklyn, Brooklyn, N. Y.

WHEATON, WALTER ROBERT. Care, San Joaquin Light & Power Co., Tulare and H Sts., Fresno, Cal.

WILCOCK, FREDERICK. 23 Flatbush Ave., Brooklyn, N. Y.

WILDES, WALDO GILMAN. Res. Engr., Barge Canal Office, Albany, N. Y.

WILKERSON, THOMAS JEFFERSON. Asst. Engr. Bridge Designer, Bureau of Constr., Dept. of Public Works, City Hall, Pittsburg, Pa.

ASSOCIATE MEMBERS (*Continued*).

Williams, Jacob Paul Jones. Asst. Prof. of Civ. Eng., Columbia Univ., New York City.

Wilson, James Bean. 87 Todd Bldg., Louisville, Ky.

Wonson, Samuel Lamson. 179 Belmont St., Belmont, Mass.

Yappen, Adolph. Dist. Carpenter, C., M. & St. P. Ry., Western Ave. (Res., Cor. North California and Grand Aves.), Chicago, Ill.

Zorn, George Washington. Hydr. and Gen. Eng., Germania, Wyo.

ASSOCIATES

Bruce, John Moffatt. Gen. Sales Mgr., United Mfrs., 250 West 54th St., New York City.

Herron, George Merrick. Bin 12, Bakersfield, Cal.

Wrenn, James Francis. Stillwater, N. Y.

JUNIORS

Ackemann, Henry Conrad. 254 McMillen, Portland, Ore.

Baldridge, James Ramsey. Care, Sherman Square Hotel, 71st St. and Broadway, New York City.

Banks, Charles Wilbur. Box 456, Pleasantville Sta., N. Y.

Bernstein, Lester. Office Asst. to Chf. Engr., B. & O. R. R., B. & O. Bldg., Baltimore, Md.

Bigelow, William Walter. Care, J. R. Worcester & Co., Greenwood Ave., Waltham, Mass.

Bishop, Hiram Nelson. 1002 E. Spruce St., Seattle, Wash.

Bishop, Lyman Edgar. Filmore, Albany County, Wyo.

Black, Roger Derby. 1st Lieut., Corps of Engrs., U. S. A., Engineer Camp, Templeton, Cal.

Breitzke, Charles Frederick. Asst. Engr., New York Board of Water Supply, Cold Spring, N. Y.

Burnham, George Earle. 27 Rand St., Central Falls, R. I.

Bushell, Arthur William. 617 Hope St., Providence, R. I.

Cantwell, Herbert Herluin. Asst. Supervisor of Track, N. Y. C. & H. R. R. R., Croton, N. Y.

Carpenter, J. C. 201 N. Natchez Ave., North Yakima, Wash.

Chace, Amasa Manton. Grand Junction, Colo.

Collins, Francis Winfield. 346 Broadway, New York City.

Crowell, Francis Stirling. Asst. Engr., Barge Canal Contr. No. 69, Barge Canal Office, Mechanicsville, N. Y.

Cunningham, John Wilbur. Draftsman, Bridge Dept., North Coast R. R. Co., 828 E. Indiana Ave., Spokane, Wash.

Dibert, Herbert McMillen. Structural Engr., with Raymond M. Booth, Albany Trust Co. Bldg., Albany (Res., 10 First St., Troy), N. Y.

Dimmler, Charles Louis. 1002 East Spruce St., Seattle, Wash.

Faucette, William Dollison. Care, Seaboard Air Line Ry., 24 Broad St., New York City.

JUNIORS (*Continued*).

Fox, William Frederick. Asst. to Rd. Engr., Interborough Rapid Transit Co., M. of W. Dept.; Address, 108 East 22d St., New York City.

Gibble, Isaac Oberholzer. Care, Bartlett & Ranney, Ave. C and Travis, San Antonio, Tex.

Goodman, Harry Minott. 1366 S. King St., Honolulu, Hawaii.

Gotwals, John Carl. Kitchawan, N. Y.

Gregson, Alvero Charles. 20 Marlboro Rd., Flushing, N. Y.

Gross, Joseph Watson. 2456 Derby St., Berkeley, Cal.

Halcombe, Norman Marshall. Salmon, Idaho.

Harper, Frederick Clayton. Care, Unit Constr. Co., Liggett Bldg., St. Louis, Mo.

Hatch, Frederick Nathaniel. Care, Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City.

Hayes, Ferdinand Eugene, Jr. 303 Coleman Bldg., Louisville, Ky.

Haywood, Charles Ellsworth. Asst. Engr., Elec. Traction Dept., P. R. R., Pennsylvania Station, 7th Ave. and 32d St., New York City.

Hazen, Ralph William. Whitefield, N. H.

Hohl, Leonard Louis. Salmon, Idaho.

Hughes, William Richard, Jr. Box 58, East Liberty Y. M. C. A., Pittsburg, Pa.

King, Arthur Caswell. Asst. Engr., Springfield Water-Works (Res., 650 Chestnut St.), Springfield, Mass.

Lewis, Wilfred. Care, MacArthur Concrete Pile & Foundation Co., 1126 Harvard Ave., Seattle, Wash.

Lillich, Joseph Thomas. Care, New York Telephone Co., Buffalo, N. Y.

Mahone, William, Jr. Care, Chf. Engr.'s Office, N. S. Ry., Norfolk, Va.

Martinez, Rolando Arnoldo. 107 San Miguel, Havana, Cuba.

Maynard, Henry Warner. Care, The Brown Hoisting Machinery Co., Cleveland, Ohio.

Millard, William John. Care, Forminiere, Kanyama, Manyiema, Congo Belge, West Africa, "Faire suivre S. V. P."

Mitchell, William Washington. Res. Engr., Big Blackfoot Ry. Co., Bonner, Mont.

Moulton, Oren McKenney. P. O. Box 348, Newark, N. J.

Munkelt, Frederick Hermann. Care, Empire Bridge Co., Elmira, N. Y.

Myers, George Higgins. Box 292, Tucson, Ariz.

Neuhardt, Edwin. Asst. Engr., Office of Supt., M. of W., Florida East Coast Ry., St. Augustine, Fla.

Nichol, Henry Schell. Care, Carnegie Steel Co., Newark, N. J.

Nicolaysen, Albin Georg. Special Asst., R. R. and Canal Revaluation, State of New Jersey, 55 Broad St., Elizabeth (Res., 720 Leland Ave., Plainfield), N. J.

Pagon, William Watters. 1301 St. Paul St., Baltimore, Md.

JUNIORS (*Continued*).

Peck, Charles Franklin. Asst. on Engr. Corps, Penna. Lines West, 352 Cutler St., Allegan, Mich.

Peck, John Galvin. 275 Hamilton St., Albany, N. Y.

Peters, John Marvin. Asst. Engr., Mo. Pac., Iron Mountain System (Res., 5155 Maple Ave.), St. Louis, Mo.

Potter, Edwin James. Y. M. C. A. Bldg., New Bedford, Mass.

Pruett, Grover Cleveland. City Engr., Miles City, Mont.

Querbach, Earl. Draftsman, Am. Bridge Co., Ambridge Plant; Address, 510 Blackburn Ave., Sewickley, Pa.

Reed, Frank Edward. State Dept. of Highways; Address, "Camp Ritali," Windham-on-the-Catskill, N. Y.

Rennell, Henry Hurd. 430 Waldemere Ave., Bridgeport, Conn.

Riegel, Ross Milton. Box 72, Cedarhurst, N. Y.

Schmid, Robert John. Carlyle Hotel, Spokane, Wash.

Seeley, Henry Arthur. Insp., Reinforced Concrete Bridge, Pequonock River at Bridgeport, 1437 Park Ave., Bridgeport, Conn.

Steegmuller, Charles Albert Augustine. Stone Ridge, Ulster Co., N. Y.

Stewart, Walter Phelps. 406 Scripps Bldg., San Diego, Cal.

Stilson, Charles Edward. 109 Langley Ave., Detroit, Mich.

Swensson, Otto Jordan. Care, Board of Water Supply of New York City, Yorktown Heights, N. Y.

Tefft, William Wolcott. Care, Kalamazoo Development, Kalamazoo, Mich.

Toll, Roger Wolcott. Eng. Dept., Denver City Tramway Co., Denver, Colo.

Tutherly, George Cotton. Claremont, N. H.

Tyler, Richard Gaines. 1513 Clay St., Waco, Tex.

Tyler, William Rogers. 2528 Broadway, New York City.

Walker, Edward George. 337 Beverley Rd., Hull, England.

Wentworth, George Lansing. Care, New York City Board of Water Supply, Hill View Reservoir (Res., 11 West Radford St.), Yonkers, N. Y.

Wilbanks, John Robert. 601 Deseret News Bldg., Salt Lake City, Utah.

Willis, Albert Jones. 6911 Paschall Ave., West Philadelphia, Pa.

FELLOWS

Blatchford, Eliphalet W. 1111 La Salle Ave., Chicago, Ill.

DEATHS

Comfort, Silas Gildersleeve. Elected Associate March 31st, 1891; died July 13th, 1910.

Goad, Charles Edward. Elected Member September 7th, 1881; died June 10th, 1910.

Irwin, Roger Brooke. Elected Associate Member May 3d, 1910; died May 23d, 1910.

JACKSON, WILLIAM. Elected Member September 3d, 1884; died June 30th, 1910.

MACHARG, WILLIAM STORRS. Elected Member December 2d, 1903; died May 6th, 1910.

MCBEE, VARDRY ECHOLS, JR. Elected Associate Member October 7th, 1908; died June 20th, 1910.

MCKAY, JOHN EDWARDS. Elected Member July 5th, 1893; died May 13th, 1910.

MARDEN, HENRY HERMAN, JR. Elected Member May 1st, 1901; date of death unknown.

RICHARDSON, CLINTON LEROY. Elected Junior September 2d, 1902; Associate Member October 2d, 1907; died July 7th, 1910.

ROWE, SAMUEL MCMATH. Elected Member September 2d, 1885; died May 22d, 1910.

SAMPLE, JOHN HENDERSON. Elected Member October 6th, 1886; died March 4th, 1910.

SMITH, ALBERT MATHER. Elected Member May 5th, 1886; died February 27th, 1910.

Total Membership of the Society, August 1st, 1910, 5 595.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(May 10th to July 22d, 1910)

NOTE.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal,* Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings,* Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions,* Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly,* Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator,* Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine,* New York City, 25c.
(10) *Cassier's Magazine,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News,* New York City, 15c.
(14) *Engineering Record,* New York City, 12c.
(15) *Railway Age Gazette,* New York City, 15c.
(16) *Engineering and Mining Journal.* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway and Engineering Review,* Chicago, Ill., 10c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 10c.
(21) *Railway Engineer,* London, England, 25c.
(22) *Iron and Coal Trades Review,* London, England, 25c.
(23) *Bulletin,* American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal,* New York City, 10c.
(25) *American Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique,* Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France.
(34) *Portefeuille Economiques des Machines,* Paris, France.
(35) *Nouvelles Annales de la Construction,* Paris, France.
(37) *Revue de Mécanique,* Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways,* Paris, France.
(41) *Modern Machinery,* Chicago, Ill., 10c.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Pontes et Chaussées,* Paris, France.
(44) *Journal,* Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals,* Scranton, Pa., 20c.
(46) *Scientific American,* New York City, 8c.
(47) *Mechanical Engineer,* Manchester, England.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(51) *Deutsche Bauzeitung,* Berlin, Germany.
(52) *Rigasche Industrie-Zeitung,* Riga, Russia.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions,* Am. Soc. C. E., New York City, $4.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.

(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $5.
(57) *Colliery Guardian,* London, England.
(58) *Proceedings,* Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.
(59) *Transactions,* Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.
(60) *Municipal Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *Industrial World,* 59 Ninth St., Pittsburg, Pa.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 20c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Journal of Gas Lighting,* London, England, 15c.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(68) *Mining Journal,* London, England.
(70) *Engineering Review,* New York City, 10c.
(71) *Journal,* Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.
(73) *Electrician,* London, England, 18c.
(74) *Transactions,* Inst. of Min. and Metal., London, England.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
(76) *Brick,* Chicago, Ill., 10c.
(77) *Journal,* Inst. Elec. Engrs., London, England.
(78) *Beton und Eisen,* Vienna, Austria.
(79) *Forscherarbeiten,* Vienna, Austria.
(80) *Tonindustrie Zeitung,* Berlin, Germany.
(81) *Zeitschrift für Architektur und Ingenieurwesen,* Wiesbaden, Germany.
(83) *Progressive Age,* New York City, 15c.
(84) *Le Ciment,* Paris, France.
(85) *Proceedings,* Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.
(86) *Engineering-Contracting,* Chicago, Ill., 10c.
(87) *Roadmaster and Foreman,* Chicago, Ill., 10c.
(88) *Bulletin* of the International Ry. Congress Assoc., Brussels, Belgium.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa.
(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(94) *The Boiler Maker,* New York City, 10c.
(95) *International Marine Engineering,* New York City, 20c.
(96) *Canadian Engineer,* Toronto. Ont., Canada, 15c.
(97) *Turbine,* Berlin, Germany, 1 Mark.
(98) *Journal,* Engrs. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $1.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., $1.
(101) *Metal Worker,* New York City, 10c.
(102) *Organ für die Fortschritte des Eisenbahnwesens,* Wiesbaden, Germany.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, Eng., 6d.
(105) *Metallurgical and Chemical Engineering,* New York City, 25c.

LIST OF ARTICLES.

Bridges.

Notes on the Replacing of the Superstructure of the Harlem Ship Canal Bridge.* Horace J. Howe, M. Am. Soc. C. E. (54) Vol. 67.
Construction of Lethbridge Viaduct, Crow's Nest Branch, Canadian Pacific Railway Company.* C. N. Monsarrat. (5) Oct., 1909.
Report on Strengthening the Bridges with a View to Increasing the Weight of Locomotives and the Speed of Trains (France and Italy); Subject for Discussion at the Eighth Session of the Railway Congress.* Eugene Randich. (88) Apr.
Tyngs Island Bridge of the Vesper Country Club, Lowell, Mass.* James W. Thomas, M. Am. Soc. Mech. E. (Paper read before the Bost. Soc. Civ. Engrs.) (1) May.
Bellows Falls Arch Bridge.* Joseph R. Worcester. (Paper read before the Bost. Soc. Civ. Engrs.) (1) May.
Decay and Protection of Railway Bridges.* (12) May 6.
The Waterproofing of Extensive Railroad Bridge Floors.* (14) May 14.
The Copper River Bridge Piers.* (14) May 14.

---

* Illustrated.

Bridges—(Continued).

An 18 000-ft. Steel Arch as a Quebec Bridge Project.* (13) May 19.

Determination of Wind Stresses in Three-Hinged Arches.* J. Ensink. (14) May 21.

A 109-ft. Concrete-Floor Plate-Girder Bridge.* (14) May 21.

Shoring Channel Span, South 22d Street Bridge, Pittsburg.* (14) May 28.

An Early Specification for a Steel Bridge; the Glasgow Bridge Over the Missouri River. (13) June 2.

Arch Coefficients. Transformation of Dimensions in Symmetrical Rib Arches; with Tables of Coefficients for Twenty Arches of Different Proportions. Malverd A. Howe. (13) June 2.

The Twentieth Street Viaduct, Denver, Colorado.* (14) June 4.

The Langebro Harbour Bridge, Copenhagen. (11) Serial beginning June 10.

Method and Cost of Constructing Three Short-Span, Single-Track Concrete Arch Bridges, Lake Champlain & Moriah Railroad.* (86) June 15.

A Long Reinforced-Concrete Railway Viaduct through the City of Rotterdam, Holland.* (13) June 16.

Wide Span Ferro-Concrete Bridge in New Zealand.* (12) June 17.

Notes on Recent American Bridges. (12) June 24.

Hoisting Concrete for a Bridge Floor. (14) June 25.

Comparative Economy of Steel I-Beams with Jack Arches vs. Reinforced Concrete for Railroad Culverts and Short Span Solid Floor Bridges.* Frank H. Carter, Assoc. M. Am. Soc. C. E. (86) June 29.

Experience with Day Labor Work in the Maintenance and Repairs of Bridges in Chicago, Ill. (86) June 29.

The Seventh Street Bridge, Los Angeles, California.* (14) July 2.

Second Series of Concrete Model-Arch Tests for Medina Aqueduct, New York State Barge Canal.* (From *Barge Canal Bulletin.*) (13) July 7; (14) July 9; (86) July 20.

A New Method of Proportioning Webs and Stiffeners in Plate Girders.* H. M. Gibb. (11) July 8.

Double Track Truss Bridge with Suspended Tracks.* (15) July 8.

The Hudson River Bridge at Waterford, New York.* H. N. Peck. (13) July 14.

Quebec Bridge Substructure.* (96) July 14.

The Design and Construction of the Paulin's Kill Viaduct.* (14) July 16.

Appareils de Dilation des Ponts Métalliques.* A. Nachtergal. (35) May.

Le Prolongement de la Rue de Rennes, à Paris, et le Projet de Pont en X sur la Seine.* E. Hénard. (33) May 14.

Mécanismes de Translation des Ponts Roulants.* A. Nachtergal. (34) June.

Le Calcul Graphique de l'Arc Continu.* Louis Schaffner. (33) Serial beginning June 4.

Le Viaduc du Gorgopotamos (Grèce); Reprise en Sous-Oeuvre des Fondations d'une Pile et d'une Culée.* Georges Bodin. (33) June 18.

Le Renforcement des Ponts Métalliques en vue de l'Augmentation du Poids et de la Vitesse des Trains.* Jean Phizey. (33) July 9.

Beiträge zur Theorie und Berechnung der vollwändigen Bogenträger ohne Scheitelgelenk, insbesondere der Brückengewölbe und der im Eisenbetonbau üblichen biegungsfesten Rahmen.* Max Ritter. (79) Vol. 11.

Neuere Eisenbeton-Brücken.* Rank. (51) Serial beginning *Beton Beilage* No. 11.

Ueber Niete und Vernietungen.* (50) Serial beginning May 11.

Vom Neubau der Augustus-Brücke in Dresden.* Pressprich. (51) Serial beginning June 8.

Strassenüberführung auf Bahnhof Kieritzsch.* Em. Haimovici. (78) June 10.

Electrical.

A 2 750-Volt Direct Current System.* A. H. Barringer. (5) Oct., 1909.

A Practical Method of Protecting Insulators from Lightning and Power Arc Effects. L. C. Nicholson. (42) Mar.

On the Modifications in Hering's Laws of Furnace Electrodes Introduced by Including Variations in Electric and Thermal Resistivity. A. E. Kennelly. (42) Mar.

The Proportioning of Electrodes for Furnaces.* Carl Hering. (42) Mar.

Large Electric Hoisting Plants. Wilfred Sykes. (42) Mar.

Motor Application to Machine Tools.* Charles Fair. (42) May.

Disruptive Strength with Transient Voltages.* Joseph L. R. Hayden and Charles P. Steinmetz. (42) May.

Observation of Harmonics in Current and in Voltage Wave Shapes of Transformers.* John J. Frank. (42) May.

Parallel Operation of Three-Phase Generators with their Neutrals Interconnected.* George I. Rhodes. (42) May.

The Second Kelvin Lecture, the Work of Lord Kelvin in Telegraphy and Navigation.* J. A. Ewing. (77) May.

An Investigation as to the Most Economical Vacuum in Electric Power Stations Employing Steam Turbines and Cooling Towers.* R. M. Neilson. (77) May.

The Testing of Rubber for Electrical Work.* A. Schwartz. (77) May.

---

* Illustrated.

Electrical—(Continued).

The Influence of Various Cooling Media upon the Rise in Temperature of Soft Iron Stampings. R. D. Gifford. (77) May.
Some Notes on Overhead Line Construction.* W. B. Woodhouse. (77) May.
The Electrical Driving of Textile Machinery.* W. B. Woodhouse. (10) May.
New Methods of Transmission Employed in Wireless Telegraphy. G. Ferrié. (Abstract from the *Bulletin* de la Soc. Inter. des Electriciens.) (73) May 6.
Aerial Telephone Lines on the Pupin System.* A. Ebeling. (Paper read before the Elek. Ver.) (73) May 6.
High-Tension Switchgear, with Special Reference to Mining and Colliery Developments.* M. B. Field. (Abstract of paper read before the South Wales Inst. of Engrs.) (22) May 6.
Cost of Generating and Distributing Electricity for Lighting and Power, New York Edison Co. (86) May 11.
Telegraph Cable Relay.* (27) May 12.
The Boston Opera House.* (27) May 12.
Long Underground Telephone Lines on Pupin System. A. Ebeling.* (27) May 12; (73) May 13.
Calculation of Illumination by the Point-by-Point Method.* Alfred A. Wohlauer. (27) May 12.
Electric Cables. F. Fernie. (73) Serial beginning May 13.
Supports for Transmission Lines.* C. T. Wilkinson. (27) May 19.
Transmission Insulators.* A. S. Watts. (27) May 19.
Union Electric Light and Power Company.* (27) May 19.
Short-Circuit Losses in Alternating-Current Commutor Motors.* A. Fraenckel and B. J. M. Lane. (73) Serial beginning May 20.
The Voltage Regulation of Alternators.* (12) May 20.
The Thorne-Baker Tele-Photographic Apparatus.* (46) May 21.
Concrete Poles for a Transmission Line.* (14) May 21.
The Danville Central Station System.* (27) May 26.
The Single-Phase Commutator Generator. Val. A. Fynn. (27) Serial beginning May 26.
New Wireless Telegraphy and Telephony Instruments.* (12) May 27; (73) May 27.
A London Electric Supply Station.* (12) Serial beginning May 27; (73) Serial beginning May 20.
Central Argentine Railway Workshops Electrification.* (12) May 27.
Improvements Suggested in Underground Conduit Construction for Large Transmission Systems.* Edw. N. Lake. (4) June.
The Application of Porcelain to Strain Insulators.* W. H. Kempton. (42) June.
Electric Railway Catenary Trolley Construction.* W. N. Smith. (42) June.
Transmission Line Crossings of Railroad Rights-of-Way. Allen H. Babcock. (42) June.
The Generating System of an Electric Lighting Company.* A. R. Cheyney. (42) June.
Telephone Engineering Around the Golden Gate. Arthur Bessey Smith. (42) June.
The Modern Oil Switch with Special Reference to Systems of Moderate Voltage and Large Ampere Capacity. A. R. Cheyney. (42) June.
Metal Filament Lamps.* John W. Howell. (42) June.
Some Developments in Modern Lighting Systems. C. W. Stone. (42) June.
Synchronizing Alternators.* S. G. Winn. (10) June.
The Electric Driving of Cotton-Picking Machinery.* Albert Walton. (10) June.
Economical Small Electric Plants.* Warren H. Miller. (27) June 2.
Housatonic River Hydroelectric Plants.* J. Franz. (27) June 2.
The Electrical Equipment of Messrs. Edward Lloyd, Ltd., Salisbury Square, London, E. C.* (26) June 3.
Electricity in French Gas Plant.* Warren H. Miller. (27) June 9.
New Ideas in Electrical Distribution Methods.* S. B. Way, Assoc. Am. Inst. E. E. (Abstract of paper read before the National Elec. Light Assoc.) (13) June 9.
Transmission-Line Crossings Over Railroads; Accidents and Causes. (Abstract from Joint Report, National Elec. Light Assoc. and Ry. Eng. and M. of W. Assoc.) (13) June 9.
Direct-Current Turbo-Generators. W. L. Waters, M. Am. Inst. E. E. (Abstract of paper read before the National Elec. Light Assoc.) (13) June 9.
The Greenock Electricity Undertaking.* (26) June 10.
Wireless Telegraphy for Marine Intercommunication.* W. W. Bradfield. (73) June 10.
Reinforced Concrete Poles. R. D. Coombs and C. L. Slocum. (Abstract of paper read before the Assoc. of Amer. Portland Cement Mfrs.) (14) Serial beginning June 18.
Problems in Power Transmission. H. W. Buck, M. Am. Inst. E. E. (Abstract of paper read before the National Elec. Light Assoc.) (13) June 23.

---

* Illustrated.

Electrical—(Continued).

Some Applications of Concrete and Cement to a Central Station System. H. N. Muller. (Abstract from *Elec. Engr.*) (86) June 29.
Distribution of Energy in Colorado.* (27) June 30.
Vector Power in Alternating-Current Circuits.* A. E. Kennelly. (42) July.
The Electric Strength of Air.* J. B. Whitehead. (42) July.
Determination of Transformer Regulation Under Load Conditions and Some Resulting Investigations.* Adolph Shane. (42) July.
Dielectric Strength of Oil. H. W. Tobey. (42) July.
Carbon Filament Lamps as Photometric Standards. E. B. Rosa and G. W. Middlekauff. (42) July.
Some Recent Developments in Exact Alternating Current Measurements. Clayton H. Sharp and William W. Crawford. (42) July.
American Telegraph Engineering, Notes on History and Practice.* William Maver, Jr., and Donald McNicol. (42) July.
The International Electrical Units, 1893-1910. E. B. Rosa. (42) July.
Magnetic Hysteresis.* Morton G. Lloyd. (3) July.
Mechanical Tests of Insulator Porcelain and Glass.* Ralph P. Clarkson. (27) July 7.
The Scherbius Motor and Some Methods of Working It in Cascade with Induction Motors.* Reginald O. Kapp. (73) July 8.
Notes on Transmission Line Regulation.* P. M. Lincoln. (96) July 14.
A London Municipal Central Station; Generating Station of the Westminster Electric Supply Corporation.* (27) July 14.
Concrete Conduits for Electric Cables.* (13) July 14.
Gas Explosions in an Electric Conduit, New York City. A. A. Breneman, M. Am. Chem. Soc. (13) July 14.
Electricity in the Construction of the Los Angeles Aqueduct.* (14) July 16.
Concrete High Tension Switch-Boards. (14) July 16.
Electrical Transmission in Michigan.* (27) July 21.
A Wireless Telegraph Station; How to Construct a 1 000-Mile Receiving Station.* Edward H. Guilford. (19) Serial beginning July 23.
Usine Electrique du Landy, à la Plaine-St. Denis (Seine); Société du Gaz de Paris.* (34) May.
Die neuen Fernsprech-Zentralanlagen der Direktion Frankfurt a. M.* G. Foerster. (102) Serial beginning May 15.
Die Erzeugungskosten der elektrischen Kraft unter Ausnutzung des Hochofengases. Rudolf Pokorny. (50) June 8.
Installation elektrischer Licht- und Kraftanlagen in Eisenbetonbauten.* Siegfried Ebell. (78) June 10.

Marine.

The Second Kelvin Lecture, the Work of Lord Kelvin in Telegraphy and Navigation.* J. A. Ewing. (77) May.
The Problems of Winter Navigation on the St. Lawrence River.* H. T. Barnes. (96) May 13.
His Majesty's Battleship *Hercules*.* (11) May 13.
The German Cruiser *Van der Tann*.* (12) May 13.
The Design of Manœuvring Gear for Marine Steam Turbines.* (12) May 13.
The Porhydrometer—An Apparatus for Weighing Ship Cargoes. (46) May 14.
Steel Suction Dredge.* (96) May 20.
Light-Draft Sand-Pump Dredge *Quorra* for Improvement of the River Niger.* (96) May 20; (13) June 16.
The New Russian Battleships.* (11) May 20.
Mitsu-Bishi Dockyard and Engine Works.* (11) May 20.
The Brazilian Scout-Cruisers.* (12) May 20.
Impulse and Reaction Marine Steam Turbines. Sir William H. White. (12) May 27.
Reinforced Concrete Barges on the Pacific Division of the Panama Canal.* (14) May 28.
Bulk-Oil Steamship *J. A. Chanslor*.* (95) June.
A New Type of Iron Ore Transport.* F. C. Coleman. (95) June.
A Powerful Stern Wheel Towboat.* (95) June.
Fire Boats *David Scannel* and *Dennis T. Sullivan* for San Francisco Harbor.* (95) June.
The French Destroyer *Voltigeur*.* (12) June 3.
Steel Barges for Transporting Steel Products on the Ohio and Mississippi.* (13) June 9; (20) June 9.
The German Battleship *Rheinland*. (11) June 10.
Ships' Telephones.* H. S. Thompson. (73) June 10.
Ship Illumination and Fittings.* G. Austin. (73) June 10.
Electric Steering Gear.* A. P. Chalkley. (73) June 10.
The Wiring of Ships.* G. Austin. (73) June 10.
Electrically-Driven Shipyard Cranes.* H. H. Broughton. (73) June 10.

---

* Illustrated.

Marine—(Continued).

Marine Propulsion by Electric Motors.* Henry A. Mavor. (73) June 10.
A System of Turbo-Electric Propulsion of Ships.* H. C. Leake. (73) June 10.
Electrical Marine Propulsion on the "Paragon" System.* William P. Durtnall. (73) June 10.
A Steamship with Horizontal Corrugations Along the Hull: Results of Tests.* A. H. Haver. (Abstracts of paper read before the North East Coast Inst. of Engrs. and Shipbuilders.) (13) June 16.
The Norwegian Submersible *Kobben.** (12) June 17.
The Grand Trunk Pacific Company's T.-S. S. *Prince Rupert.** (11) June 17.
A New Fireboat for Seattle, Wash.* M. H. Strouse. (13) June 23.
Survey Steamship for Canada.* (12) June 24.
Electricity on Shipboard. J. M. Heslop. (10) July.
The Propulsion of Cargo Boats. R. M. Neilson, M. I. Mech. E. (10) July.
Passenger and Freight Steamships *City of Montgomery* and *City of St. Louis.** (95) July.
The Latest Turbine Destroyers of the French Navy.* (95) July.
Progress on Dry Dock Number 4, Brooklyn Navy Yard.* (14) July 2.
The 22 000-Ton Floating Dock for Brazil.* (12) Serial beginning July 8.
Sauvetages et Renflouements. Ribière. (43) Mar.
Le Bassin à Flot de la Société de la Gironde à Bordeaux.* M. Michel-Schmidt. (32) Apr.
Les Réparations de Navires par la Soudure Electrique et la Soudure Autogène.* A. Scott Jounger. (Paper read before the Inst. of Engrs. and Shipbuilders in Scotland.) (93) May.
Nouvelles Pompes d'Epuisement des Formes de Radoub de Potaniou, à l'Arsenal de Brest.* P. Germain. (33) June 11.
Schwimmende Fahrzeuge aus Eisenbeton.* Perrey. (15) *Beton Bcilage,* No. 13.

Mechanical.

The Smokeless Combustion of Bituminous Coal.* A. Bement. (56) Vol. 40.
The Modification of Coal by Low-Temperature Distillation. C. K. Francis. (56) Vol. 40.
The Use of Alcohol in an Internal Combustion Engine.* G. L. Guillet. (5) Oct., 1909.
Heat Transmission.* W. E. Dalby. (75) Oct., 1909.
An Internal-Combustion Pump and Other Applications of a New Principle.* Herbert A. Humphrey. (75) Nov., 1909.
On the Rate of Heat Transmission between Fluids and Metal Surfaces.* H. P. Jordan. (75) Dec., 1909.
The Development of the Gas Engine.* E. T. Adams. (61) Feb.
Centrifugal Pumps. William R. Wiley. (4) Apr.
Recent Progress in Aviation.* Octave Chanute. (4) Apr.
Advantages of Air-Separators.* D. E. Bogdahn. (67) May.
The New Plant of the Riverside Portland Cement Co.* (67) May.
Recent Progress in Motors for Aeroplanes.* W. F. Bradley. (10) May.
The Mechanical Handling of Small Materials.* George Frederick Zimmer, A. M. Inst. C. E. (10) May.
Government Plant at Washington.* F. L. Johnson. (64) May 10.
The Extension of the Zürich Gas-Works.* (66) Serial beginning May 10.
Darley Suction Conveyor for Coal and Ashes, the Installation for the Boston Elevated Railway.* (20) May 12.
Gas and Oil Engine Combustion Spaces.* James W. Naylor, A. M. I. Mech. E. (12) May 13.
Venturi Meters for Measuring Large Volumes of Gas.* J. L. Hodgson. (Paper read before the Manchester Dist. Inst. of Gas Engrs.) (66) May 13.
Gas Engines in Charlotte, N. C.* (17) May 14.
A Stone-Washing Plant at Thornton, Illinois.* (14) May 14.
Management of Water Gas Generators.* John F. Wing. (Paper read before the New Eng. Assoc. of Gas Engrs.) (83) May 16.
La Salle Hotel Power Plant, Chicago.* Osborn Monnett. (64) May 17.
Causes of the Destruction of Refractory Blocks and Retorts. Alfred B. Searle. (66) Serial beginning May 17.
Continuity of Supply in Modern Power Stations.* H. I. Lewenz. (12) Serial beginning May 20.
Feeber's Theory of Aeroplane Stability.* (11) May 20.
Petrol-Air Gas.* William Key. (66) May 24.
Increasing Capacity of Steam Boilers.* Henry Kreisinger and Walter T. Ray. (64) May 24.
Gas-Driven Blowing Plant at the Works of Messrs. Vivian & Sons, Swansea.* (22) May 27.

---

* Illustrated.

Mechanical—(Continued).

Mechanical Plant of the Provident Bank Building, Cincinnati.* Walter G. Franz. (14) May 28.
Piping for the Steam Plant.* (101) May 28.
The Fairview Pumping Station.* Thurlow E. Coon. (64) May 31.
Operating Costs of Large Units.* (64) May 31.
Chicago's Smoke Problem.* Paul P. Bird. (4) June.
Interaction of Flywheels and Motors when Driving Roll Trains by Induction Motors.* F. G. Gasche. (42) June.
Humidifiers, their Principles and Useful Application.* Sterling H. Bunnell. (9) June.
A Japanese Watertube Boiler.* (94) June.
Arsenic Manufacture at Midvale.* Leroy A. Palmer. (45) June.
Low Pressure Turbines. J. G. Callan. (98) June.
The Effect of Preliminary Heat Treatment upon Clays. A. V. Bleininger. (76) June.
Some Practical Experiences in the Drying of Tiles. H. L. Straight. (Paper read before the Iowa Brick and Tile Assoc.) (76) June.
Utilizing Waste Kiln Heat. J. C. Trautwein. (76) June.
A Modern Stone Crushing Plant of 600 Cu. Yds. Capacity per Hour, Some Costs of Drilling, of Maintenance of Plant, and of Erecting Machinery.* (86) June 1.
A Boiler-Testing Installation and the Economical Combustion of Fuel. Charles Edward Larard, Assoc. M. Inst. C. E. (11) Serial beginning June 3.
Thermal Storage.* (12) June 3.
Power Plant Economizers.* Frank Kingsley. (14) June 4.
A Simple and Accurate Gas Calorimeter.* H. Strache. (Abstract from *Journal für Gas Beleuchtung.*) (24) June 6.
Marseilles' New Power Plant.* Alfred Gradenwitz. (64) June 7.
The Arrangement of Valves in Aeroplane Engines.* (11) June 10.
The Stumpf Uni-Directional-Flow Engine.* J. Stumpf. (11) June 10.
Boat and Rail Telpher Transfer Plant.* (15) June 10.
Power Investigation in a Grain Mill. (14) June 11.
New Apparatus for Measuring Deformations in Materials. H. C. Berry. (14) June 11.
Iron vs. Tin Meters* (Gas). A. G. Holmes. (Paper read before the Natural Gas Assoc. of Amer.) (24) June 13; (83) July 15.
Side Feed Automatic Stoker.* J. F. Springer. (64) June 14.
Iron Moulds for Making Castings.* (12) Serial beginning June 17.
The Quantity of Circulating Water Required in Surface Condensers.* R. M. Neilson. (12) June 17.
Exhaust Steam Turbines and Condensing Plant at McDonald Road Station.* F. A. Newington. (Paper read before the Inc. Mun. Elec. Assoc.) (73) June 17; (26) June 24; (47) June 17.
Automatic Recording Instruments.* (47) Serial beginning June 17.
Extensions to Existing Electricity Supply Stations by Means of Mixed Pressure Turbines.* Ashton Bremner. (Paper read before the Inc. Mun. Elec. Assoc.) (47) June 17.
Leigh-on-Sea Gasworks Extensions, with Particular Reference to Reinforced Concrete Gasholder Tank.* Charles F. Hunt. (Paper read before the Inc. Assoc. of Mun. and County Engrs.) (104) June 17.
Gas Heating Research.* (Report of a Comm. to the Inst. of Gas Engrs.) (66) June 21.
Gas Calorimetry in the United States.* John B. Klumpp. (Paper read before the Inst. of Gas Engrs.) (66) June 21.
Investigations with Respect to Carbonizing in Horizontal Retorts. J. Ferguson Bell. (Paper read before the Inst. of Gas Engrs.) (66) June 21.
Experiments in Carbonization on the Birmingham Coal Test Plant. William B. Davidson. (Paper read before the Inst. of Gas Engrs.) (66) June 21.
The Brouwer Stoking Machinery and Coke-Handling Plant.* S. Y. Shoubridge. (Paper read before the Inst. of Gas Engrs.) (66) June 21.
The Extrusion of Metals in the Solid State.* (20) June 23.
New McKeesport Tin Plate Mills.* (20) June 23.
Large Diameter Shot Drilling in Concrete.* (13) June 23.
A Reinforced-Concrete Locomotive Coaling Station of 2 000 Tons Capacity.* L. M. Ewell. (13) June 23.
Elementary Theory of the Gyroscope.* E. H. Barton. (11) June 24.
Mechanical Road Haulage, Considered Commercially. H. T. Harris. (Paper read before the Irish Road Congress.) (86) June 29.
Test of a 170-H.P. Oil Engine. H. P. Macdonald. (27) June 30.
Pitot Tube Steam Flow Meters.* (13) June 30.
The Mining and Fabrication of Fireclay. A. S. B. Little. (9) July.

---

* Illustrated.

Mechanical—(Continued).

The Revival of the Reciprocating Engine.* R. J. S. Pigott. (9) Serial beginning July.

Specifications for Foundry Coke. Richard Modenke. (Paper read before the Amer. Foundrymen's Assoc.) (41) July.

The Hopkins Gasolene-Engine Dynamometer and Speedometer.* N. Monroe Hopkins. (3) July.

Modern Car-Wheel Turning.* Walter L. Clark. (10) July.

An Automatic Coke Waterer.* William L. Affelder. (45) July.

Brush-Parsons Exhaust Turbine.* (11) July 1.

Alignment Chart for Determining Specific Volumes of Steam.* William J. Goudie, A. M. I. Mech. E. (11) July 1.

Hydraulic Turbines for 670-Foot Head.* H. Birchard Taylor. (64) July 5.

The Forest (Brussels) Gas-Works.* (66) Serial beginning July 5.

The Utilization of Exhaust Steam.* Herman Niemetz. (27) July 7.

De Laval High Efficiency Centrifugal Pumps.* (20) July 7.

High-Speed Steam-Turbine Rotor Design and Construction.* John McKenzie Newton. (Paper read before the Junior Inst. of Engrs.) (11) Serial beginning July 8.

Cylinder Moulding for Railway Engines.* H. Pemberton. (Paper read before the Brit. Foundrymen's Assoc.) (22) July 8.

Mechanical Transference of Water-Borne Freight. H. M'L. Harding. (15) July 8.

Rules and Regulations Governing Inspection of Gas, New York Public Service Commission, Second District. (24) July 11.

The New Hoboken Gas-Works at Antwerp.* (66) July 12.

Gasoline-Electric Truck for Haulage in Arid Regions.* W. D. Hornaday. (27) July 21.

A 15-Ton Hulett Ore Unloader.* Walter G. Stephan. (20) July 21.

Les Indicateurs de Torsion Appliqués à la Mesure de la Puissance des Machines.* P. Moulin. (31) 1910, Pt. 1.

Etude Comparée sur le Procédé Classique de Fabrication du Plâtre dit des "Fours Culées" et le Procédé Perin. L. Périn. (32) Mar.

Les Terres Rares et l'Eclairage à l'Incandescence.* Nicolardot. (92) Apr.

Les Turbo-Machines Multicellulaires et leurs Récentes Applications.* A. Rateau. (32) Apr.

Description de Quelques Turbo-Machines et Comparaisons de Celles-ci avec les Machines à Piston Correspondantes.* A. Barbezat. (32) Apr.

Quelques Remarques sur les Turbo-Machines.* J. Rey. (32) Apr.

Moteurs Aéronautiques et Croiseur Aérien.* J. A. Farcot. (92) May.

Turbine "Série-Parallèle" Oerlikon Fonctionnant avec de la Vapeur Fraîche.* (33) May 7.

Le Controle Mécanique et Physique de la Combustion dans les Foyers Industriels.* Eugène Grandmougin. (33) May 7.

L'Exposition d'Aviation et de Navigation Automobile de l'Olympia (Londres, 11-19 Mars, 1910).* Ch. Dantin. (33) May 14.

Machine Frigorifique à Eau Système Westinghouse-Leblanc.* E. Lemaire. (33) May 28.

Conduite Mécanique de la Chauffe dans les Foyers des Générateurs de Vapeur.* M. Emanaud. (33) Serial beginning May 28.

Machines à Forger "Ajax".* (33) May 28.

La Théorie des Régulateurs à Ressorts Lamellaires.* R. Loewy. (37) May 31.

Machine à Mesurer le Rendement des Vis Origines de la Vis et des Engrenages.* Ch. Frémont. (37) May 31.

Betrachtungen über das Flugproblem.* L. Prandtl. (48) Apr. 30.

Rateaupumpen und neuere Anlangen mit Rateaupumpen. Ernst Blau. (53) May 6.

Neuere Konstruktionen von Dampfturbinen.* K. Körner und F. Lösel. (48) Serial beginning May 7.

Die Verladeanlage der Radzionkaugrube in Oberschlesien.* M. Buhle. (48) May 7.

Der Genauigkeitsgrad von Hochdruckmessern.* G. Klein. (48) May 14.

Der heutige Stand der Flugtechnik in Theorie und Praxis.* F. Bendemann. (48) Serial beginning May 14.

Schleifmaschine für alle Lagerstellen an Lokomotiv-Achssätzen.* Simon. (102) May 15.

Verlauf der Kühlzonen bei Rückkühlanlagen in Abhängigkeit von den atmosphärischen Verhältnissen.* Willnecker. (97) Serial beginning May 20.

Der Wright-Motor der Neuen Automobil-Gesellschaft in Oberschöneweide bei Berlin.* Dierfeld. (48) May 28.

Kleine Motorwagen.* A. Heller. (48) Serial beginning June 4.

Konstruktive Neuerungen an Walzenstrassen im letzten Jahrzehnt.* H. Ortmann. (50) June 15.

Ueber Gaserzeuger.* J. Hofmann. (50) June 15.

Versuche mit Hubschrauben.* G. Klingenberg. (48) June 18.

---

* Illustrated.

Mechanical—(Continued).

Ueber die Kühlung von Gasturbinen.* W. Gentsch. (97) June 20.
Ueber die Wirtschaftlichkeit der verschiedenen Antriebsarten von Stahlwerks-Gebläsemaschinen.* Mauritz. (50) June 22.
Das Walzen von Fein- und Weissblechen.* W. Krämer. (50) July 6.
Die Abhängigkeit der Wärmeübergangszahl von der Rohrlänge.* Wilhelm Nusselt. (48) July 9.

Metallurgical.

Cyaniding Slime.* Mark R. Lamb. (56) Vol. 40.
The Cyaniding of Silver-Ores in Mexico.* Albert F. J. Bordeaux. (56) Vol. 40.
Blast-Pressure at the Tuyeres and Inside the Furnace.* R. H. Sweetser. (56) Vol. 40.
Kentucky Fluorspar and Its Value to the Iron and Steel Industries. F. Julius Fohs. (56) Vol. 40
Pan-Amalgamation: An Instructive Laboratory-Experiment.* H. O. Hofman and C. R. Hayward. (56) Vol. 40.
Development in the Size and Shape of Blast-Furnaces in the Lehigh Valley, as Shown by the Furnaces at the Glendon Iron Works.* Frank Firmstone. (56) Vol. 40.
Metal-Losses in Copper-Slags. Lewis T. Wright. (56) Vol. 40.
The Treatment of Slime on Vanners.* Rudolf Gahl. (56) Vol. 40.
The Influence of Bismuth on Wire-Bar Copper.* H. N. Lawrie. (56) Vol. 40.
The Limit of Fuel-Economy in the Iron Blast-Furnace. N. M. Langdon. (56) Vol. 40.
The Assay and Valuation of Gold-Bullion.* Frederic P. Dewey. (56) Vol. 40.
Sintering of Fine Ore and a Sintering Machine.* Alfales B. Young. (105) May.
The New Blast Furnace of the Bethlehem Steel Company.* W. S. Landis. (105) Serial beginning May.
Electric Furnaces in Non-Ferrous Metallurgy. Joseph W. Richards. (105) May.
Causes of Non-Uniformity of Blast Furnace Operation. Edward B. Cook. (105) May.
Electric Furnaces of the Induction Type.* T. Rowlands. (Paper read before the Amer. Electrochemical Soc.) (20) May 12; (62) May 16; (47) June 3.
Recent Advances in the Electrometallurgy of Zinc.* Franz Peters. (Abstract from *Glückauf.*) (16) May 14.
Recent Reverberatory Smelting Practice. Redick R. Moore. (16) Serial beginning May 14.
An Electric Smelting Furnace.* Edward R. Taylor. (20) May 19.
New Mill of the Tonopah Extension Mining Co.* (16) May 21.
Report by F. W. Harbord on the Manufacture of Iron and Steel in the Transvaal. (12) Serial beginning May 27.
The Elements of Slime Concentration. Walter McDermott. (Abstract from *Bull.*, I. M. M.) (16) May 28.
Improvements in the Cyanide Process.* Bernard MacDonald. (103) May 28.
Smeltery Smoke as a Source of Sulphuric Acid.* W. H. Freeland and C. W. Renwick. (16) May 28.
Electrolytic Refining of Copper.* G. H. Blakemore. (Abstract from *Proc.*, Australasian Inst. of Min. Engrs.) (45) Serial beginning June.
Vanadium Steel. William E. Gibbs. (10) June.
The Electric Furnace in the Iron and Steel Industry. G. Hooghwinkel. (Abstract of paper read before the Sheffield Soc. of Engrs. and Metallurgists.) (73) June 3.
The Microscope and Some of its Applications to Metallurgy.* Wirt Tassin. (Paper read before the Philadelphia Foundrymen's Assoc.) (20) June 9.
Iron and Steel Works at Hanyang, Hupe, China.* A. J. Seltzer. (16) June 11.
Thin-Lined Blast-Furnaces.* (20) June 16.
Large Gas Engines in Steel Works.* Richard Bechtel. (Abstract of paper read before the Birmingham Assoc. of Mech. Engrs.) (20) June 16.
Copper Converters with Basic Lining. Redick R. Moore. (16) June 25.
A Quantitative Investigation of the Source of Hydrogen in Blast Furnace Gas. R. J. Wysor and W. D. Brown. (105) July.
Continuous Pachuca Tank Agitation at the Esperanza Mill.* M. H. Kuryla. (Paper read before the Inst. de Minas y Metal.) (105) July.
Grüner's Ideal Working of a Blast Furnace. Joseph W. Richards. (Paper read before the Inter. Cong. of Min. and Metal.) (105) July.
Electrostatic Separation of Minerals in Ores.* Henry A. Wentworth. (16) July 2.
Recent Improvements in the Construction of the Open-Hearth Furnace.* O. Friedrich. (Paper read before the Inter. Cong. at Dusseldorf.) (22) July 8.
Note sur l'Application des Souffleries Rotatives aux Hauts Fourneaux. A. Gouvy. (32) Apr.
Notes sur l'Organisation de Quelques Laboratoires Allemands et Belges.* G. Arnou. (93) June.

---

* Illustrated.

Metallurgical—(Continued).

Etude Métallographique des Scories du Fer et de l'Acier.* M. Matweieff. (93) June.

Hochöfen im Ural.* O. Höhl. (50) May 18.

Ueber die theoretische und praktische Bedeutung des elektrischen Hochofens. Carl Brisker. (50) June 22.

Ueber den heutigen Stand der Elektrostahlverfahren.* B. Neumann. (50) June 22.

Ueber Strom- und Spannungsverhältnisse im elektrischen Ofen.* Walter Conrad. (50) June 22.

Ueber Weissblecherzeugung.* B. v. Clement. (50) July 6.

Military.

Design and Construction of Artillery Wheels.* (12) July 1.

Mining.

Hydraulic Dredging for Gold-Bearing Gravels.* Henry G. Granger. (56) Vol. 40.

Pressure-Fans vs. Exhaust-Fans. Audley H. Stow. (56) Vol. 40.

The Coal-Mines and Plant of the Stag Cañon Fuel Co., Dawson, N. M.* Jo. E. Sheridan. (56) Vol. 40.

Conditions and Costs of Mining at the Braden Copper-Mines, Chile. William Braden. (56) Vol. 40.

The Geology, Mining, and Preparation of Barite in Washington County, Missouri.* A. A. Steel. (56) Vol. 40.

The Barometric and Temperature Conditions at the Time of Dust-Explosions in the Appalachian Coal-Mines.* N. H. Mannakee. (56) Vol. 40.

A New Separator for the Removal of Slate from Coal.* W. S. Ayres. (56) Vol. 40.

Modern Progress in Mining and Metallurgy in the Western United States. David W. Brunton. (56) Vol. 40.

The Ruble Hydraulic Elevator.* J. McD. Porter. (56) Vol. 40.

Modern Practice of Ore-Sampling.* David W. Brunton. (56) Vol. 40.

Fire-Damp: Its Composition, Detection and Estimation. Thomas Gray. (59) Vol. 32, Pt. 4.

An Electrical Safety System for Use in Mines.* H. J. Fisher. (77) May.

The Tube-Mill Circuit and Classification. G. O. Smart. (Abstract of paper read before the Chem., Met. and Min. Soc. of South Africa.) (105) May.

Automatic Protective Switchgear for Colliery Service.* E. B. Wedmore. (Abstract from *Trans.*, Inst. of Min. Engrs.) (73) May 6.

Electricity in Colliery Sinking Operations.* (26) May 6.

Storage Batteries in Colliery Work.* J. Glynn Williams. (Paper read before the Inst. of Min. Elec. Engrs.) (22) May 6.

Cost of Dredging in Russia and Siberia (Gold). W. H. Shockley. (103) May 7.

Outbursts of Gas in Coalmining. (From *Zeit. für Berg-, Hutten-und Salinenwesen.*) (57) Serial beginning May 13.

Some Notes on Methods of Constructing Concrete Lined Shafts.* (86) May 18.

Evolution of Mine Haulage.* (45) Serial beginning June.

Current Pumps for Mining.* Frank Reed. (45) June.

Mining on a Royalty Basis.* Lucius J. Wittich. (45) June.

A Storage-Battery Extension to a Three-Phase Colliery Power Plant.* William Maurice. (Paper read before the Inst. of Min. Engrs.) (22) June 3; (57) June 3.

Electrically Driven Pumping Plants.* (12) June 3.

Use of the Terry Core Drill in Mine Operations.* (16) June 4.

Sinking the Woodward No. 3 Shaft.* R. V. Norris. (16) June 4.

Steam-Driven Transmission System.* (27) June 16.

The Sinking and Equipment of the Littleton Collieries.* T. H. Bailey, M. Inst. C. E. (Paper read before the South Staffordshire and Warwickshire Inst. of Min. Engrs.) (57) June 17; (22) June 10.

An Analysis of the Coal Dust Problem. Audley H. Stow. (16) June 18.

Reclaiming Flooded Drift Mines in Alaska.* W. H. Lanagan. (103) June 18.

Los Pilares Mine, Nacozari, Mexico.* Courtenay DeKalb. (103) June 18.

Leinweber Method of Extracting Oil from Wells.* Frederick A. Talbot. (16) June 18.

Method of Working a Steep Coal Seam. Austin Y. Hoy. (16) June 25.

Mining at Miami, Arizona.* R. L. Herrick. (45) July.

Mine Resistance. Thomas W. Fitch, Jr. (Paper read before the West Virginia Coal Min. Inst.) (45) July.

The Beaver Brook Breaker.* Truman M. Dodson, Jr. (45) July.

Electric Rope Haulage.* W. O. Vickery. (45) July.

Deep Pumping on the Comstock.* (45) July.

Electricity in West Virginia Mines.* R. Neil Williams. (16) July 2.

Less Known Gold Dredges in California.* W. M. Knox. (103) July 2.

Stoping at Homestake Mine of South Dakota.* John Tyssowski. (16) July 9.

---

* Illustrated.

Mining -(Continued).

Gold Dredging and Rock Crushing in California.* George Bowers. (14) July 16.
Mining Coal with Explosives.* C. E. Munroe and Clarence Hall. (Abstract from *Bul.*, U. S. Geol. Surv.) (19) July 16.
Copper Mining in Metcalf District, Arizona.* Peter B. Scotland. (16) July 16.
Surface Condenser in Mine Power Plants.* W. A. Macleod. (16) July 16.
La Station d'Essais de Liévin.* J. Taffanel. (32) Mar.
La Distribution par Courant Continu en Série dans les Mines.* (33) Apr. 30.
Perforatrices à Commande Pneumatique, Hydraulique ou Electrique.* F. Hofer. (33) July 9.
Versuche mit verschiedenen Bohrlochauskleidungen.* F. v. Emperger. (78) Serial beginning July 2.

Miscellaneous.

Precarious Expedients in Engineering Practice. John Hawkesworth, Assoc. M. Am. Soc. C. E. (54) Vol. 67.
Some English Exhibits at Buenos Ayres' Exhibition.* (12) Serial beginning May 6.
Limitations of Efficiency in Engineering Education.* George Fillmore Swain. (Paper read before Union Univ.) (13) May 12.
Earthwork Shrinkage, Application and Amount. E. B. Espenshade. (86) June 1.
Allowances for Interest, Engineering and Contingencies. (14) June 25.
Formulæ for the Design of Gravity Retaining Walls.* W. H. Rose. (100) July.
The Necessity for Standardizing Contract Forms. R. Walter Creuzbaur. (Paper read before the National Assoc. of Comptrollers and Accounting Officers.) (14) July 2.
Tables pour le Calcul de la Poussée des Terres.* J. Roman. (31) 1910, Pt. 1.
L'Ultra-Microscope et le Cinématographe.* J. Comandon. (32) Mar.
Représentation Graphique des Fonctions à 3 Variables.* L. Jannin. (37) Apr. 30.
Un Grand Inventeur: Sir Henry Bessemer.* Henry Le Chatelier. (93) May.

Municipal.

Toronto Pavements.* C. H. Rust. (99) Vol. 16.
Pavements and Their Grade Limitations in the Borough of the Bronx. S. C. Thompson. (99) Vol. 16.
Paving Practice with Respect to Crowns of Roadway Pavements and Concrete Foundations.* George C. Warren. (99) Vol. 16.
Storm Drainage at Street Intersections.* J. H. Weatherford. (99) Vol. 16.
Creosote Oil for Wood Block Pavements. James Nisbet Hazlehurst. (99) Vol. 16.
Bituminous Pavements on Macadam Base.* Linn White. (99) Vol. 16.
Concrete Pavement now being Laid in Boise, Idaho. J. B. Marcellus. (99) Vol. 16.
Three Years' Experience with Oiling Roads.* Frederick A. Reimer. (99) Vol. 16.
Some Observations on Asphalt Paving and Some Present Needs. Harry Tipper. (99) Vol. 16.
Coal Tar for Road Making. R. O. Wynne-Roberts. (Abstract of paper read before the Soc. of Engrs.) (66) May 3; (104) Serial beginning July 1.
The Planning of Undeveloped City Areas. Nelson P. Lewis, M. Am. Soc. C. E. (Paper read before the Conference on City Planning.) (13) May 12; (14) May 14.
Standard Specifications for Underground Construction Adopted by the City of Seattle, Washington.* H. L. Estep. (13) May 12.
Up-to-Date Roads.* R. O. Wynne-Roberts, M. Inst. C. E. (Paper read before the Soc. of Engrs.) (104) May 13.
The Use of Tar on Roads.* A. D. Whittaker. (Paper read before the Amer. Gas Inst.) (83) May 16.
A Few Remarks in Regard to Surface-Spraying of Roads with Tar and Making *in Situ* Tar-Macadam. T. Aitken, M. Inst. C. E. (104) May 20.
Road Construction and Maintenance. R. F. Grantham. (Paper read before the Surveyors' Inst.) (104) May 20.
Specifications for Oiling Roads in New York State. (96) May 27.
Road Maintenance. William Menzies. (Paper read before the Surveyors' Inst.) (104) May 27; (86) June 22.
Chicago's Smoke Problem.* Paul P. Bird. (4) June.
Brick Paved Highways.* W. P. Blair. (Paper read before the National Brick Mfrs.' Assoc.) (60) June.
The Steam Roller on Roads, and the Management and Care of Steam Road Rollers. (86) June 8.
Local Improvements.* Geo. Ross. (Paper read before the Ontario Land Surveyors.) (96) June 10.
Comparative Cost of Macadam and Stone Block Pavements at Belfast, Ireland. (86) June 15.

---

* Illustrated.

Municipal—(Continued).

A Comparison of the Specifications for Creosoted Wood Paving Blocks of Fourteen American Cities. (86) June 15.

Public Lighting from a Municipal Point of View.* Jacques Abady, M. I. Mech. E. (Paper read before the Inst. of Gas Engrs.) (66) June 21; (73) July 8.

Life and Cost of Maintenance of Wood Block Pavement at Hampstead, England. (86) June 29.

The Construction of Sand-Clay Roads in Western Kansas. W. S. Gearhart. (Abstract of paper read before the Missouri Highway Engrs.' Assoc.) (13) June 30.

Specifications for Wood Block Paving for Richmond Road Viaduct, Ottawa, Ont. (96) June 30.

Notes on Road Building in Cuba.* Mason M. Patrick. (100) July.

Motive Powers for Municipal Engineers. Arthur E. Collins, M. Inst. C. E. (Paper read before the Inc. Assoc. of Mun. and County Engrs.) (104) July 1.

Chicago Waste Disposal System.* (14) July 2.

A Road Roller of Improved Design with Novel Form of Front Truck.* (13) July 7.

Appareils à Goudronner, système J. Lassailly.* A. Moreau. (92) Jan.

Système de Goudronnage des Routes, par J. Vinsonneau.* A. Moreau. (92) Jan.

Note sur les Rouleaux Compresseurs avec Moteurs à Mélange Tonnant.* Bret. (43) Mar.

Le Prolongement de la Rue de Rennes, à Paris, et le Projet de Pont en X sur la Seine.* E. Hénard. (33) May 14.

Der neue Bebauungsplan für Chicago.* Werner Hegemann. (51) Serial beginning May 18.

Railroads.

The New York Tunnel Extension of the Pennsylvania Railroad.* Charles W. Raymond, M. Am. Soc. C. E. (54) Vol. 68.

The New York Tunnel Extension of the Pennsylvania Railroad; the North River Division.* Charles M. Jacobs, M. Am. Soc. C. E. (54) Vol. 68.

The New York Tunnel Extension of the Pennsylvania Railroad; the East River Division.* Alfred Noble, Past-Pres., Am. Soc. C. E. (54) Vol. 68.

The New York Tunnel Extension of the Pennsylvania Railroad; Meadows Division and Harrison Transfer Yard.* E. B. Temple, M. Am. Soc. C. E. (54) Vol. 68.

The New York Tunnel Extension of the Pennsylvania Railroad; the Bergen Hill Tunnels.* F. Lavis, M. Am. Soc. C. E. (54) Vol. 68.

The New York Tunnel Extension of the Pennsylvania Railroad; the North River Tunnels.* B. H. M. Hewett and W. L. Brown, Members, Am. Soc. C. E. (54) Vol. 68.

The New York Tunnel Extension of the Pennsylvania Railroad; the Site of the Terminal Station.* George C. Clarke, M. Am. Soc. C. E. (54) Vol. 68.

The New York Tunnel Extension of the Pennsylvania Railroad; the Cross-Town Tunnels.* James H. Brace and Francis Mason, Members, Am. Soc. C. E. (54) Vol. 68.

The New York Tunnel Extension of the Pennsylvania Railroad; the East River Tunnels.* James H. Brace, Francis Mason, and S. H. Woodard, Members, Am. Soc. C. E. (54) Vol. 68.

The New York Tunnel Extension of the Pennsylvania Railroad; the Terminal Station-West.* B. F. Cresson, Jr., M. Am. Soc. C. E. (54) Vol. 68.

Driving Headings in Rock Tunnels.* W. L. Saunders. (56) Vol. 40.

A Reliable Steel Rail and How to Make it. James E. York. (56) Vol. 40.

Determination of Train Resistance.* E. I. Wenger. (5) Oct., 1909.

Report on the Use of Steel: Special Steels (Countries belonging to the "Verein Deutscher Eisenbahn-Verwaltungen"); Subject for Discussion at the Eighth Session of the Railway Congress. Otto Hönigsberg. (88) Apr.

Report on the Operation of Switches and Signals (Holland); Subject for Discussion at the Eighth Session of the Railway Congress.* L. H. N. Dufour. (88) Apr.

Report on Rail-Joints (France, Belgium, Italy, Spain and Portugal); Subject for Discussion at the Eighth Session of the Railway Congress.* Chateau. (88) Apr.

Report on Improvements in Locomotive Boilers (Austria-Hungary, Rumania, Bulgaria, Servia and Turkey); Subject for Discussion at Eighth Session of the Railway Congress.* Johann Papp. (88) Apr.

Report on Rail-Joints; Subject for Discussion at the Eighth Session of the Railway Congress.* Blum. (88) Apr.

The Panama Railroad and its Relation to the Panama Canal.* Ralph Budd. (4) Apr.

Report (France, Belgium, Italy, Spain and Portugal) on Improvements in Locomotive Boilers; Subject for Discussion at the Eighth Session of the Railway Congress.* C. Dassesse. (88) May.

---

* Illustrated.

Railroads—(Continued).

Report (Austria, Hungary, Bulgaria, Rumania, Servia and Turkey) on Strengthening the Track with a View to Increasing the Weight of Locomotives and the Speed of Trains; Subject for Discussion at the Eighth Session of the Railway Congress. Hermann Rosche. (88) May.

Report (Austria, etc.) on Rail-Joints; Subject for Discussion at the Eighth Session of the Railway Congress.* Friedrich Kramer. (88) May.

Report (America) on Large Stations; Subject for Discussion at the Eighth Session of the Railway Congress.* H. A. Jaggard. (88) May.

Report (Russia) on Improvement in Locomotive Boilers; Subject for Discussion at the Eighth Session of the Railway Congress.* G. Noltein. (88) May.

Report (Russia) on Improvements in Locomotive Boilers; Subject for Discussion at the Eighth Session of the Railway Congress.* N. Atochine. (88) May.

The Railways of Brazil. Lionel Wiener. (10) Serial beginning May.

Terminal Freight Handling by Electrical Machinery.* H. McL. Harding. (98) May.

The Safe Transportation of Explosives and Other Dangerous Articles.* J. L. Taylor. (98) May.

Heavy Tank Engines.* (21) May.

The Big Signal-Box at York; North-Eastern R.* (21) May.

Mallet Articulated Locomotives; Southern Pacific Co.* (21) May.

Stresses Developed by Collisions of Freight Cars.* B. W. Dunn. (65) May.

Blankense-Ohlsdorf High-Tension Single-Phase Railway.* Gustav Dietl. (27) May 12.

Recent Development in American Locomotives. (12) May 13.

Snow Removal by Steam Heat.* (15) May 13.

Mallet Locomotive for the Burlington.* (15) May 13.

Combination Lock and Block and Automatic Signals for Single-Track Sections, Central New England Ry.* (18) May 14.

Air Pump and Main Reservoir Capacity for Freight Service.* P. J. Langan. (Abstract of paper read before the Air Brake Assoc.) (18) May 14.

The Pennsylvania Railroad Terminal in New York.* (19) May 14.

Specifications for Air Signal Hose (Penn. R.R.) (15) May 20.

Tests to Determine the Effect of Low Temperatures on Air Brake Hose and Coupling Gaskets.* W. J. Hatch. (Abstract of paper read before the Air Brake Assoc.) (15) May 20.

New Union Passenger Station, Winnipeg.* (14) May 21.

Maintenance of Way Improvements and Methods, New York Central R.R.* (18) May 21.

Air Pump Piping.* (Abstract of report to the Air Brake Assoc.) (18) May 21.

A British Trackless Trolley Line.* (18) May 21.

Valuation of the Puget Sound Electric Railway. Henry L. Gray, Assoc. M. Am. Soc. C. E. (86) May 25.

The Necessity of Depreciation Reserves. Henry L. Gray, Assoc. M. Am. Soc. C. E. (15) May 27.

Mallet Articulated Compound Locomotive for the Delaware & Hudson Co.* (15) May 27; (25) June; (47) July 8; (18) June 18.

Expansion of Locomotive Boiler Sheets.* (15) May 27.

Heavy 3 ft. 6 in. Gauge Locomotive.* (21) June.

Reversible Working, London Bridge; L., Brighton and S. C. R.* (21) June.

"Era" Manganese-Steel Crossings.* (21) June.

Steel Frame Box Cars, Canadian Pacific Railway.* (25) June.

Test of Locomotive Driving Wheels.* E. L. Hancock. (25) June.

Heavy Articulated Locomotives, Northern Pacific Railway.* (25) June.

Railroad Shop Layouts.* F. Kingsley. (25) June.

The Mechanical Principles of Brennan's Mono-Rail Car. Henry T. Eddy. (3) June.

Electro-Mechanical Locomotives.* A. P. Chalkley. (10) June.

Locomotive Headlights.* C. H. Benjamin. (61) Apr. 19.

Inequality of Expansion in Locomotive Boilers and the Possibility of Eliminating the Bad Effects Therefrom.* R. D. MacBain. (65) June.

Tests of a Locomotive Using Superheated Steam; Atchison, Topeka and Santa Fé Railway.* (13) June 2; (18) Serial beginning May 28; (25) June.

Care and Handling of Electrical Equipment, New York Central & Hudson River.* F. E. Lister. (15) June 3.

Removable Driving Box Bearing.* (15) June 3.

The San Diego & Arizona Ry.* (18) June 4.

The Average Car-Mile Cost of Operating Seventy-Five Electric Railways in New York State, Second District. (86) June 8.

The Successful Locomotive Mechanical Stoker: Pennsylvania Lines West of Pittsburgh.* (15) June 10.

The Principles Governing the Arrangement of Automatic Block Signals. W. H. Arkenburgh. (15) June 10.

---

* Illustrated.

Railroads—(Continued).

Car Weights as Affecting Operating Costs.* M. V. Ayres. (Abstract of paper read before the Amer. St. and Interurban Ry. Eng. Assoc.) (96) Serial beginning June 10.

Autogenous Welding in a Railway Shop.* H. W. Jacobs. (15) June 17.

Curve Easements; Present Practice. (15) June 17.

Relining Compound Curves.* W. H. Wilms. (15) June 17.

Tonnage Rating for Fast Freight Trains.* J. G. Van Zandt. (15) Serial beginning June 17.

Hybrid Mallet Units for the Erie and Chicago Great Western Railroads.* (18) June 18.

Mallet Articulated Locomotives for the Norfolk & Western Ry.* (18) June 18; (25) July.

Some Suggestions for Economical Track Maintenance and Construction.* Martin Schreiber. (17) June 18.

The Winnipeg Railway Terminal Elevated Passenger Yard.* (14) June 18.

The New Chicago Station of the Chicago and North-Western Ry.* (14) June 18; (15) July 15.

A 120-Ft. Turntable for Handling Mallet Locomotives with Their Tenders; A., T. & S. F. Ry.* (13) June 23; (15) July 1.

The Terminal Controversy at St. Louis. Samuel O. Dunn. (15) June 24.

Locomotives at the Brussels Exhibition.* (12) Serial beginning June 24.

Mechanical Stokers. (Report to the Amer. Ry. Master Mechanics Assoc.) (18) June 25.

Methods and Costs of Railroad Surveys in Bolivia.* C. A. Bock. (14) June 25.

Traffic and Physical Development of an Iowa Railroad.* (17) June 25.

The Block Signal Question. James Brandt Latimer. (13) June 30.

Economy of Car Operation.* Cyril J. Hopkins. (42) July.

Front End Tests; Results of a Series of Tests on the Locomotive Testing Plant at Altoona.* (25) Serial beginning June; (15) July 15.

Pacific and Consolidation Type Locomotives, Chicago & Northwestern Railway.* (25) July.

A Tabular Comparison of Notable Examples of Recent Locomotives, Arranged with Respect to Total Weights. (25) July.

Freight Train Resistance, its Relation to Average Car Weight.* Edward C. Schmidt. (Paper read before the Amer. Ry. Master Mechanics' Assoc.) (25) July.

The Design of the Electric Locomotive.* N. W. Storer and G. M. Eaton. (42) July.

Headlight Tests.* C. Francis Harding and A. N. Topping. (42) July.

Steam Heating for Railway Carriages.* (21) July.

Pacific Type Locomotives, Class 10; Belgian State Railway.* (21) July.

Standard Permanent Way; North Eastern Railway.* (21) July.

The Barsi Light Railway.* (21) July.

Phonopore Telephones.* (21) July.

The Brewster Shops of the Wheeling & Lake Erie.* (15) July 1.

Crampton Locomotives.* (12) July 1.

The Electrification of the Lapland Railway.* (11) July 1.

The Arica-La Paz Railway. (14) July 2.

Winnipeg, Selkirk & Lake Winnipeg Interurban Railway.* (17) July 2.

The Latest Development in Car Wheels for Electric Railways.* V. S. Yarnell. (Paper read before the St. Ry. Assoc. of State of N. Y.) (17) July 2.

Railway Motor Gears and Pinions. T. W. Williams. (Abstract of paper read before the St. Ry. Assoc. of the State of N. Y.) (17) July 2.

Standardization of Track Construction in Paved Streets. Benjamin E. Tilton. (Abstract of paper read before the St. Ry. Assoc. of the State of N. Y.) (17) July 2.

Recent Developments in Multiple-Unit Control and other Electric Railway Apparatus.* Clarence Renshaw. (Abstract of paper read before the St. Ry. Assoc. of the State of N. Y.) (17) July 2.

A Railway Signal with Illuminated Background.* J. H. Wisner, Jr. (Abstract of paper read before the Ry. Signal Assoc.) (13) July 7.

Railless Traction. H. England. (Abstract of paper read before the Tramways and Light Rys. Assoc.) (73) July 8.

The Single-Phase Railway between Rotterdam, the Hague and Scheveningen.* C. Van Langendonck. (15) July 8.

Steel in Freight Car Construction.* C. A. Seley. (15) July 8.

Copper River & Northwestern Railroad, Alaska.* L. W. Storm. (16) July 9.

Method and Cost of Raising Embankment and Filling Trestles Using Steam Shovel and Hart Convertible Cars with Lidgerwood Unloader. (86) July 13.

Australia's Railway System and Some of its Problems.* Jas. Alex. Smith. (Abstract of paper read before the Victorian Inst. of Engrs.) (13) July 14.

---

* Illustrated.

Railroads—(Continued).

New Tank Car.* (15) July 15.
New Shops of the Central of Georgia Ry., Macon, Ga.* (18) July 16.
The 1 200-Volt D. C. Interurban Lines of the Milwaukee Electric Railway & Light Company.* John R. Hewett. (17) July 16.
The Elementary Theory of the Gyroscope in the Brennan Monorail Car.* Edward V. Huntington. (13) July 21.
Reconstruction of the Washington Street Tunnel under the Chicago River.* (13) July 21.
Steam Turbine Electric Locomotive.* (15) July 22.
Locomotive and Car Shops of the National Trans-Continental, Winnipeg, Canada.* (15) July 22.
Note sur les Progrès Réalisés dans l'Etablissement des Enclenchements.* Pierre Lefort. (43) Mar.
Note sur l'Explosion de Locomotive de Bertry.* Anglès-Dauriac. (43) Mar.
Les Trains Automobiles à Propulsion Continue.* A. Doniol. (38) May.
Locomotive Tender Compound à Deux Cylindres Inégaux et Six Roues Couplées pour Voie d'un Mètre.* R. Séguéla. (38) May.
Note sur la Ligne de Djibouti à Addis-Abeba.* R. Godfernaux. (38) June.
La Nouvelle Chaudière à Foyer à Tubes d'Eau à l'Essai sur la Locomotive à Grande Vitesse 2.741 de la Compagnie du Nord.* J. Koechlin. (38) June.
Les Chemins de Fer Electriques en Autriche-Hongrie.* (33) June 18.
Note sur le Matériel de la Compagnie Internationale des Wagon-Lits et des Grand Express Européens, Construit de 1872 à 1909.* (38) July.
Chemins de Fer du Rio Grande du Sud (Brésil).* Lionel Wiener. (38) July.
Etat Actuel des Travaux du Chemin de Fer des Alpes Bernoises (Berne-Loetschberg-Simplon).* Ch. Dantin. (33) July 2.
Der Tunnel unter dem Aermelkanal. Paul Konta. (81) Pt. 3.
Gleislose elektrische Bahnen. A. Heller. (48) Apr. 30.
Wechselstrom-Güterzuglokomotive der New York, New Haven und Hartford-Bahn.* K. Meyer. (48) Apr. 30.
Lokomotiv-Sandstreuer mit Dampf- und Pressluft-Betrieb.* H. Oelert. (102) May 1.
Einschienenbahn und Kreiselwagen.* G. Barkhausen. (102) Serial beginning May 1.
Werkstättenanlagen der dänischen Staatsbahnen.* O. Busse. (102) June 1.
Der neue Zentralbahnhof in Pilsen.* J. Basta. (102) Serial beginning June 15.
Längs- und Querbewegliche Federhängung von Hajdu und Sarlós.* (102) June 15.
Die Hauptwerkstätte Istvàntelek der ungarischen Staatseisenbahnen.* B. Gönczy und A. Bíró. (102) Serial beginning June 15.
Die Lokomotiven auf der Weltausstellung in Brüssel, 1910.* D. Metzeltin. (48) July 9.

Railroads, Street.

The Construction of Street Railways and Pavements About the Tracks.* John N. Ambler. (99) Vol. 16.
Tee Rails in Paved Streets.* D. A. Hegarty. (99) Vol. 16.
Equitable Charges for Tramway Supply.* H. E. Yerbury. (77) May.
South London Subways; Details of the Elephant and Castle Scheme.* (104) May 6.
Track Standards and General Rules—Department of Maintenance of Way—Metropolitan Street Railway.* (17) May 14.
Painting Practice on London Underground Railways. (17) May 21.
Electrical Department of the Metropolitan Street Railway, New York.* (17) Serial beginning May 21.
Passenger Traffic Handling on Elevated Trains at the Manhattan Terminal of the Brooklyn Bridge.* (13) May 26.
Influence of Tramways on Street Paving.* R. O. Wynne-Roberts. (Paper read before the Inc. Assoc. of Mun. and County Engrs.) (104) May 27; (86) June 29.
Reconstruction of Part of the Manhattan Elevated Railway.* (14) May 28.
Low Tension Feeder Systems for Street Railways.* R. H. Rice. (4) June.
Chicago Traffic Conditions in the Congested District.* (14) June 4.
Brooklyn Line Department, the Novel Iron-Bar Overhead Construction.* (17) June 11.
Replacing and Depressing the Manhattan Elevated Railway.* (14) June 11.
The Treatment of Depreciation of Street Railway Properties. Frank R. Ford. (Paper read before the Amer. St. and Interurban Ry. Assoc.) (86) June 15.
Speed Control Signals on the Interborough.* J. M. Waldron. (Abstract of paper read before the Ry. Signal Assoc.) (15) June 17.
Center Side Door Steel Cars for New York Subway.* (17) June 18.

---

* Illustrated.

Railroads, Street—(Continued).

Brooklyn Line Department, Special Overhead Work at Movable Bridges.* (17) June 18.

Brake Shoe Standardization.* J. A. Panton. (Abstract of paper read before the Tramways and Light Railways Assoc.) (73) June 24.

A Method for Determining the Adequacy of an Electric Railway System.* R. W. Harris. (42) July.

Power Economy in Electric Railway Operation, Coasting Tests on the Manhattan Railway, New York.* H. St. Clair Putnam. (42) July.

The Paris Metropolitan Railway.* (12) July 1.

Reinforced Concrete Foundations for Track.* (17) July 2.

Notes on Durham, N. C. (Durham Traction Co.)* (17) July 2.

Construction and Operating Features of the Winnipeg Electric Railway.* (17) July 9.

Report on the Pittsburgh Subway. (Abstract.) Bion J. Arnold. (15) July 22; (17) July 9.

Report on Pittsburgh Conditions.* (17) July 23.

Brooklyn Line Department, Efficiency Features of Construction and Maintenance.* (17) July 23.

Le Métropolitain de Paris, Traversée de la Seine par la Ligne No. 4, Parties Exécutées au Bouclier et par Congélation.* P. Calfas. (33) May 21.

Die Weltstädte und der elektrische Schnellbahnverkehr.* (51) Serial beginning May 7.

Sanitation.

The Improved Water and Sewage Works of Columbus, Ohio.* John H. Gregory, M. Am. Soc. C. E. (54) Vol. 67.

Disinfection of Sewage and Sewage Effluents. Earle B. Phelps. (99) Vol. 16.

Materials for Sewer Inverts.* Edward S. Rankin. (99) Vol. 16.

Garbage Reduction and Disposition of the By-Products.* Charles S. Wheelwright. (99) Vol. 16.

Public Sanitary Station at Brookline.* Alexis H. French. (Paper read before the Boston Soc. of Civ. Engrs.) (1) Apr.

Public Sanitary Station at Lawrence.* Arthur D. Marble. (Paper read before the Boston Soc. of Civ. Engrs.) (1) Apr.

Stipulations between the United States and the Passaic Valley Sewerage Commission Regarding the Discharge of Sewage into New York Bay. (13) May 12.

Glasgow Sewage Disposal.* (12) May 13.

The North Shore Channel of the Sanitary District of Chicago.* C. R. Dart. (14) May 14.

Sewerage and Sewage Disposal Works, Lichfield.* W. B. Chancellor. (96) May 27.

The Maidstone Typhoid Epidemic.* William P. Mason. (28) June.

Drain Tile and Drainage.* M. P. Post. (76) June.

The Effect of Sewage and Sewage Gases on Concrete. Sidney H. Chambers. (Abstract of paper read before the Concrete Inst.) (13) June 2; (14) May 14; (60) June.

The New Sewage Experiment Station of the Massachusetts Institute of Technology.* C.-E. A. Winslow and Earle B. Phelps, Assoc. Am. Soc. C. E. (13) June 2.

The Heat Supply in Central Heating. J. D. Hoffman. (Abstract of paper read before the National Dist. Heating Assoc.) (101) Serial beginning June 4; (70) May.

The New Sewerage System of Louisville, Ky.; General Description of the System.* (86) June 8.

The Metropolitan Sewerage Commission against the Discharge of Treated Passaic Valley Sewage into New York Bay. (14) June 9.

Flushing the West Branch of Bubbly Creek, Chicago.* (14) June 11.

Sewage Pumping Plant at Woodside, Long Island.* (14) June 11.

Details of the Design of the Sewers of Louisville, Ky.* (86) June 15.

Individual Sewage Purification Plant.* (101) June 18.

General Methods of Constructing the Louisville Sewers with Some Data on Costs.* (86) June 22.

Degree of Purification of Sewage by Screens and Grit Tanks and Methods and Costs of Purifying Sewage to Higher Degree than by Fine Screens. E. Kuichling, M. Am. Soc. C. E. (Abstract from Report to the City of Rochester.) (86) June 22; (14) May 21.

The Design and Working of a Modern Refuse Destructor. William F. Loveday. (Abstract of paper read before the Inc. Assoc. of Mun. and Co. Engrs.) (13) June 23; (47) July 8.

Methods of Constructing 2 723 Ft. of the Northwestern Trunk Sewer, Louisville, Ky., with Some Costs.* (86) June 29.

Typical Structural Details of Large Concrete Sewer Work at St. Louis, Mo., with Some Notes on the Specifications.* (86) June 29.

Septic Tank and Contact Beds for Treating the Sewage of Cherryvale, Kan.* J. S. Worley, Assoc. M. Am. Soc. C. E. (13) June 30.

---

* Illustrated.

Sanitation—(Continued).

Central Station Steam Heating. A. D. Spencer. (Abstract of paper read before the National Dist. Heating Assoc.) (64) July 5.
Methods of Construction on the Southern Outfall Sewer, Louisville, Ky., with Some Costs.* (86) July 6.
Glasgow Main Drainage and Chemical Sewage Precipitation.* R. H. Murray. (96) July 7.
New Sewers and Sewage Pumps at Richmond.* (12) Serial beginning July 8.
Difficult Sewer Reconstruction.* (14) July 9.
Air-Venting Steam Heating Systems.* Charles L. Hubbard. (101) July 9.
Tests of Milwaukee Refuse Destructor.* (14) July 16.
Warm-Air Heating Analyzed.* R. S. Thompson. (101) Serial beginning July 16.
Methods of Constructing Stream Crossings for a Large Trunk Sewer.* (86) July 20.
Method and Cost of Constructing Vitrified Pipe Sewers with Sulphur Joints. (86) July 20.
The Construction and Testing of the Milwaukee Refuse Incinerator.* Samuel A. Greeley, Jun. Am. Soc. C. E. (13) July 21.
La Pierre d'Achoppement de l'Epuration des Eaux d'Egout et le Moyen de la Tourner.* A. Puech. (92) Jan.
Quelques Chiffres à Propos de l'Hygiène des Cantonniers. Becker. (43) Mar.
Imperméabilisation et l'Assainissement des Parquets par le Mastic et l'Enduit Pulvérifuges. A. Moreau. (92) May.
Note sur le Calcul de la Section des Egouts.* Aug. Mennes. (30) June.

Structural.

Agreements for Building Contracts. William B. Bamford, Assoc. M. Am. Soc. C. E. (54) Vol. 67.
Underpinning the Cambridge Building, New York City.* T. Kennard Thomson, M. Am. Soc. C. E. (54) Vol. 67.
The Effect of Alkali on Concrete. George Gray Anderson, M. Am. Soc. C. E. (54) Vol. 67.
The New York Tunnel Extension of the Pennsylvania Railroad; the Terminal Station-West.* B. F. Cresson, Jr., M. Am. Soc. C. E. (54) Vol. 68.
The New York Tunnel Extension of the Pennsylvania Railroad; the Site of the Terminal Station.* George C. Clarke, M. Am. Soc. C. E. (54) Vol. 68.
The Hammond Mining and Metallurgical Laboratory of the Sheffield Scientific School, Yale University.* Louis D. Huntoon. (56) Vol. 40.
Mild-Steel Tubes in Compression and under Combined Stress.* William Mason. (75) Dec., 1909.
Compound Stress Experiments.* C. A. M. Smith. (75) Dec., 1909.
Paint for Iron and Steel. Frank Neal. (Paper read before the Detroit Eng. Soc.) (1) Apr.
Fused Portland Cement. C. Unger. (67) Serial beginning May.
Quartz Silica in Portland Cement Mixture. C. H. Sonntag. (67) May.
Rigid Connection of Shear Members. (From *Concrete Engineering*.) (98) May.
Waterproofing of Engineering Structures.* Joseph H. O'Brien. (Paper read before the Bost. Soc. Civ. Engrs.) (1) May.
The Corrosion of Iron and Steel.* Cecil H. Desch. (Abstract of paper read before the West of Scotland Iron and Steel Inst.) (47) May 6.
Proportions of Chain-Rings.* T. Robson, Assoc. M. Inst. C. E. (11) May 6.
A Method of Sinking Curbed Foundation Wells Using Shields and Compressed Air with Some Notes on Chicago "Caisson Foundations."* W. C. Armstrong. (Abstract from *Iowa Engineer*.) (86) May 11.
The New Timber Treating Plant of the Eppinger & Russell Co. at Jacksonville, Fla.* Grant B. Shipley. (13) May 12.
The Analytic Calculation of a Concrete Arch.* Malverd A. Howe. (13) May 12.
Putting a Concrete Jacket on a Cracked Chimney.* (96) May 13.
Underpinning a 300-Ton Column on Quicksand.* (14) May 14.
New Buildings of the Jones & Laughlin Number 14 Mill.* (14) May 14.
Comparison of Rented and Owned Concrete Mixers. (14) May 21.
The Bryant Building Substructure.* (14) May 21.
Action of Sea Water on Portland Cement.* J. M. O'Hara. (14) May 21.
Cost of the Concrete Balcony Floors of the Lockport Power House, Chicago Drainage Canal.* L. K. Sherman. (86) May 25.
A Narrow Twelve-Story Building. J. S. Branne, Assoc. M. Am. Soc. C. E. (13) May 26.
Some Formulas for Statically Indeterminate Members and Frames.* C. T. Mitchell. (13) May 26.
Wearing Surfaces for Factory Floors. (14) May 28.
Tests of Concrete for Impermeability. (14) May 28.
Sheet Steel Piling.* J. F. Springer. (10) Serial beginning June.
Wood Preservation from an Engineering Standpoint. C. T. Barnum. (4) June.
Notes on Concrete Construction.* Robert A. Cummings. (58) June.
Proposed Standard Specifications for Architectural Concrete Blocks. (67) June.

---

* Illustrated.

Structural—(Continued).

Requirements of Successful Granolithic Floor Construction with Specifications for Mill Floors. (86) June 1; (13) June 2.
Structural Economy.* E. A. Slater. (Paper read before the Inc. Assoc. of Mun. and County Engrs.) (104) June 3.
Waterproofing and Concrete. (96) June 3.
German Standards for Delivery and Testing of Portland Cement, Prepared by the "Verein Deutscher Portlandzement Fabrikanten," with the Collaboration of the Royal Testing Laboratory, at Gross-Lichterfelde, 1909. H. de Miffonis, tr. (96) June 3.
Concrete Tanks with Thin Walls.* (14) June 4.
Construction of a Large Reinforced Concrete Grandstand.* (14) June 4.
Gas-Works Extensions at Leigh-on-Sea; a Reinforced Concrete Gasholder Tank.* Charles F. Hunt, Assoc. M. Inst. C. E. (Paper read before the Inc. Assoc. of Mun. and County Engrs.) (66) June 7.
Long-Time Tests on Concrete in Sea Water. A. Poulsen. (Paper read before the Inter. Assoc. for Testing Materials.) (13) July 7.
Results of Tests made by the Louisville Sewer Commission to Determine Impermeable Mixtures for Concrete. (86) June 8.
Windsor Station Extension, Montreal, P. Q.* (96) June 10.
Wrecking the Gillender Building, New York.* (14) June 11.
Method of Inspecting and Testing Cement for the Louisville Sewer Work with Costs.* (86) June 15.
Piling and Trestling. F. R. Archibald. (Paper read before the Nova Scotia Soc. of Engrs.) (96) June 16.
A Novel Test for Resistance to Corrosion. (13) June 16.
Standard Specifications for Concrete Reinforcement Bars Adopted by the Association of American Steel Manufacturers. (13) June 16; (62) June 6; (15) June 24.
Concrete and Tile Floors with Two-Way Reinforcement.* (13) June 16.
Modern Stucco Work. Albert Moyer, Assoc. Am. Soc. C. E. (14) June 18.
Pneumatic Caisson Foundations, Whitehall Building, New York.* (14) June 18.
Corrosion of Industrial Ironwork. A. R. Warnes and W. S. Davey. (Abstract of paper read before the Soc. of Chemical Industry.) (66) June 21.
Methods of Stuccoing with Suggestions for Finishing and Coloring Stucco. Albert Moyer. (86) June 22.
Methods of Building the Foundations for a Twenty-Story Building in a Downtown District of Chicago.* (86) June 22.
A Reinforced-Concrete Locomotive Coaling Station of 2 000 Tons Capacity.* L. M. Ewell. (13) June 23.
Bearing Metals.* A. Hague. (11) June 24.
The New German Standard Specifications for Cement.* H. Burchartz. (14) June 25.
An Experiment to Determine the Pressure of Concrete upon Forms.* L. E. Ashley. (13) June 30.
Manganese Steel Castings. Chr. Holth. (100) July.
Underpinning the Astor Building, New York.* (14) July 2.
Steel Gasholder Tanks made with Bulging Sides.* Edouard Bonnet. (Paper read before the Soc. Tech. du Gaz.) (66) July 5.
The Shea Theatre from an Engineering Point of View.* A. C. Oxley. (96) July 7.
The Design of Riveted Brackets.* W. T. S. Butlin, A. M. I. C. E. (12) July 8.
Foundation Work on the Municipal Building, New York.* (14) July 9.
General Features of the Curtis Building, Philadelphia.* (14) July 9.
Methods and Costs of Making a Test of the Bearing Power of Soil for a Building.* (86) July 13.
The Condition of the Steel of the Gillender Building; a Preliminary Report.* Maximilian Toch. (13) July 14.
Testing Soil Below the Surface for Foundation Loads.* (14) July 16.
Erection of the Curtis Building, Philadelphia.* (14) July 16.
Recent Investigations on the Constitution of Portland Cement.* Clifford Richardson, M. Am. Soc. C. E. (14) July 16.
A Wood Floor Supported by Concrete Beams.* (14) July 16.
The Effect of Sea Water, Alkali Water and Sewage on Portland Cement and Methods used for Counteracting the Same. W. D'Rohan. (86) July 20.
Recherche du Dosage d'un Béton Exécuté. Framm. (Paper read before l'Assemblée Générale des Fabricants allemands de Ciment Portland.) (84) May.
Déformations d'un Cercle Elastique.* Bonneau. (43) May.
La Formation de la Rouille.* G. Bresch. (93) June.
Etude de l'Action Chimique de l'Eau de Mer sur le Ciment Portland. (84) Serial beginning June.
Normes allemandes pour l'Uniformité des Fournitures et des Essais du Ciment Portland, Décembre, 1909.* (84) June.
Versuche mit exzentrisch belasteten betoneisernen Säulen.* Maxmilian Ritter von Thullie. (79) Vol. 10.

---

* Illustrated.

Structural—(Continued).

Versuche mit Säulen aus Eisenbeton und mit einbetonierten Eisensäulen in Stuttgart und in Wien.* Fritz v. Emperger. (79) Vol. 8.
Zur Theorie des durchlaufenden Trägers.* L. Henneberg. (81) Pt. 3.
John Smeaton, der erste Forscher auf dem Gebiete der Mörteluntersuchungen. D. Quietmeyer. (81) Pt. 3.
Ein neues Betonpfahlgründungsverfahren.* Joannini. (78) Apr. 23.
Der umschnürte Beton.* Considère. (78) Apr. 23.
Eisenbeton-Kontrollbalken.* E. Suenson. (78) Apr. 23.
Eisenbetonkonstruktionen der Einsegnungshalle der Friedhofsneubauten in Rostock-Damerow.* J. Gaugusch. (78) Apr. 23.
Vorschriften für Eisenbetonbauten; die neuen Schweizerischen Vorschriften; Vergleich mit anderen Vorschriften, Vorschläge für Eisenbetonvorschriften. Erich Vossnack. (48) Apr. 30.
Die Verwendung von Eisen im Hochbau.* Fischmann. (50) May 11.
Prüfung erhitzter Schmotteziegel auf Druckfestigkeit.* (80) May 12.
Die Gründung des Kühlhauses auf dem Schlachthof in Tilsit.* Th. Janssen. (78) May 14.
Eine Zuschauertribune in Eisenbeton.* Otto Rappold. (78) May 14.
Einiges zur Rissbildung des Eisenbetons.* Otto Graf. (78) Serial beginning May 14.
Die Eisenbetonkonstruktionen in dem Neubau der Bismarck-Realschule in Stettin.* Weidmann. (78) May 14; (81) Pt. 3.
Beton mit Salzzusatz. F. v. Emperger. (78) May 14.
Beitrag zur Berechnung der Biegungsspannungen in Stein- und Betonkonstruktionen.* W. Carling. (78) Serial beginning May 14.
Eignung von Hochofen-Stückschlacke zur Betonbereitung. H. Passow. (50) May 18.
Neue Versuche Talbots mit Eisenbetonsäulen.* Max Ritter v. Thullie. (53) May 20.
Vorkommen und Verarbeitung des Molers.* Fischer-Möller. (80) Serial beginning May 24.
Knickformeln.* Th. Scharff. (51) Serial beginning June 1.
Graphostatische Berechnung von Konstruktionen aus Eisenbeton (Biegung und Achsialdruck).* K. Bakker. (78) June 10.
Brandprobe auf der Ausstellung.* (80) June 16.
Die städtischen Volksbäder in Wien.* Franz Wejmola. (53) June 24.
Die Prüfung von Trass.* (From *Mit. aus dem Kgl. Materialprüfungsamt.*) (80) Serial beginning June 25.
Berechnung des Sechsfach Statisch Unbestimmten Eisenbeton-Hallenbinders der neuen Unrat-Verbrennungsanstalt "Alter Teichweg," Hamburg-Barmbeck.* Max Bachner. (78) July 2.
Kragkonstruktion aus Eisenbeton bei Unterbauten für Freitreppen.* Weidmann. (78) July 2.
Die Verwendung von Eisen im Hochbau. H. Fischmann. (51) July 6.

Topographical.

Primary Traverse Work of the Bronx Topographical Bureau, New York City.* Edward H. Holden, M. Am. Soc. C. E. (13) May 19.

Water Supply.

The Improved Water and Sewage Works of Columbus, Ohio.* John H. Gregory, M. Am. Soc. C. E. (54) Vol. 67.
Water Supply for the Lock Canal at Panama.* Julio F. Sorzano, M. Am. Soc. C. E. (54) Vol. 67.
A Graphic Solution of Kutter's Formula.* L. I. Hewes and Joseph W. Roe. (56) Vol. 40.
Comments on Development and Operation of Hydroelectric Plants. Henry L. Doherty. (42) Dec., 1909.
Some Recent Considerations of Stresses in High Masonry Dams.* Charles E. Morrison. (6) Jan.
Raising Water by its Own Energy.* Simpson Rice. (64) May.
The Brattleboro Hydro-Electric Plant.* Lauriston Fredericks. (10) May.
The Selection of a Boiler Feed Water. J. C. William Greth. (58) May.
Tidal Power.* W. O. Horsnaill. (12) May 6.
Action of St. Louis Water on Metals and Alloys. W. F. Monfort. (Abstract of paper read before the Amer. Water-Works Assoc.) (13) May 12.
Hydroelectric Plant of the Central Georgia Power Co. (14) May 14.
Long-Distance Water Supply, El Paso & Southwestern Ry.* (18) May 14.
Keokuk Hydroelectric Plant.* (27) May 19.
The Roosevelt Dam.* (19) May 21.
The Progress of the Los Angeles Aqueduct.* (14) May 21; (103) May 14.
Deoxidizing Water to Prevent Corrosion of Steel Mains. (14) May 21.

---

* Illustrated.

Water Supply—(Continued).

Movements of a Curved Concrete Dam in Australia.* L. A. B. Wade. (14) May 21.
Hydroelectric Development on the Illinois River.* (27) May 26.
Field Work in Locating Irrigation Ditch and Canal Lines. Albert B. Bartlett, M. Am. Inst. Min. Engrs. (13) May 26.
Comparison of the Characteristic Features of Special and Stock Hydraulic Turbines. H. Birchard Taylor. (13) May 26.
The Western High-Service Reservoir of the Water Works of Baltimore, Md.* Alfred M. Quick, Assoc. M. Am. Soc. C. E. (13) May 26.
Notes on the Design of a Radial Inward-Flow Hydraulic Turbine.* Claude H. Hill. (96) May 27.
Some Extracts from and Notes upon a Recent Report on the Purification of the Water Supply of Sacramento. (96) May 27.
Dams with Overhung Batter.* Robert H. Smith. (12) May 27.
A Deep Well Sunk by Caisson.* (14) May 28.
A Method of Design of a Reinforced Concrete Siphon.* J. Ralph Van Duyne. (14) May 28.
The McCall Ferry Hydro-Electric Plant on the Susquehanna River.* (14) May 28.
Governmental Regulation of Water Powers. Marshall O. Leighton. (28) June.
Depreciation in Water-Works Accounts, with Reference to Uniform Reports. Harvey S. Chase. (28) June.
Some Published Costs of Tunnel Work in the Los Angeles Aqueduct.* (86) June 1.
Hydroelectric Development on the Niobrara River.* W. K. Palmer. (27) June 2.
Report on the Proposed Board of Water-Supply Pressure Tunnel Beneath New York City. (13) June 2.
Report on the Lindsay Ozone Water Purification Plant, by the Provincial Board of Health of Ontario.* (96) June 3.
Mechanical Gravity Filters. W. H. Humphreys. (Paper read before the Assoc. of Water Engrs.) (104) June 3.
The Moodna Pressure Tunnel of the Catskill Aqueduct.* (14) June 4.
Some Progress Data and Cost of Driving the South Portal Heading of the Elizabeth Tunnel, Los Angeles Aqueduct. (86) June 8.
Electric Irrigation Pumping in Kansas.* E. C. Reybold, Jr. (27) June 9.
Cooling-Water Intakes from the Mississippi River for Two Power Stations.* John Hunter, M. Am. Soc. M. E. (Abstract of paper read before the National Elec. Light Assoc.) (13) June 9.
The "Turn-Over" Mechanically Cleaned Filter.* (11) June 10.
The Cost of U. S. Reclamation Works. F. H. Newell. (A statement before the House Comm. on Irrigation.) (14) June 11.
The Hydroelectric Development of the Great Western Power Company—1.* (14) Serial beginning June 11.
Reservoir Outlets to Earthen Embankments. George N. Yourdi, M. Inst. C. E. (Abstract of paper read before the Assoc. of Water Engrs.) (66) June 14; (14) July 9; (104) June 24.
Records of Evaporation Obtained at 23 Different Stations in Various Parts of the United States. (13) June 16.
Decision of the Railroad Commission of Wisconsin in the Appleton Water-Works Case. (13) June 16.
Failure of a Reinforced-Concrete Circular Tank in New South Wales.* (13) June 16.
The Metropolitan Water Supply. E. Bailey-Denton, M. Inst. C. E. (12) June 17.
The Cost of Furnishing Water with Reference to Rates and Rate Making. Daniel W. Mead. (Paper read before the Amer. Water-Works Assoc.) (86) June 22.
Colorado Hydroelectric Installation.* (27) June 23.
Use of Hypochlorite in Connection with Pre-Filtration. Francis D. West. (14) June 25.
Two Power-Plant Intakes at St. Louis.* (14) June 25.
The New Buffalo Water-Works Tunnel.* F. Lavis, M. Am. Soc. C. E. (14) June 25.
Glenwood Hydroelectric Plant, Central Colorado Power Company.* (14) June 25.
Operating Results, Cincinnati Water Purification Plant. (14) June 25.
Methods and Cost of Constructing Concrete Arch and Cast Iron Pipe Culverts, by Day Labor, Illinois and Mississippi Canal. (86) June 29.
Electric Pumping for Irrigation.* Alton D. Adams. (27) June 30.
The Chaudiere Dam, Ottawa, Canada.* Douglas L. McLean. (13) June 30.
Concrete Core Wall in Moline Pool Dam in Mississippi River at Moline, Ill.* J. B. Bassett, M. Am. Soc. C. E. (100) July.
The Water Works of Madison, Wis.* Ralph Birchard. (60) July.
Hydro-Electric Developments and High Tension Practice. Percy H. Thomas. (100) Serial beginning July.
Flow of Water in Curved Pipes.* John Eustice. (Paper read before the Royal Soc.) (12) July 1.
The New Cast-Iron Conduit of the Syracuse Water Works.* (14) July 2.

---

* Illustrated.

Water Supply—(Continued).

The Laramie-Poudre Tunnel.* (14) July 2.

The Owens Valley and Olancha Divisions of the Los Angeles Aqueduct.* (14) July 2.

Method and Cost of Constructing a Concrete Tunnel Lining with an 80-Ft. Gravity Chute. W. D'Rohan. (86) July 6.

Irrigation and Electric Energy, Hydroelectric Features of Some of the Projects of the Reclamation Service.* (27) July 7.

Reinforced-Concrete Siphon for a 65-Foot Head.* (14) July 9.

Wooden Water Pipes in Australia. (101) July 9.

Colorado Hydroelectric Installation; the Boulder Generating Station of the Central Colorado Power Company.* (27) July 14.

Notes on Water-Supply of Havana, Cuba.* R. Winthrop Pratt. (13) July 14.

The Relative Value of Irrigating Waters.* Herman Stabler. (13) July 14.

The Construction of the Great Western Power Plant.* (14) July 16.

Electricity in Irrigation.* (27) July 21.

L'Usine Hydro-Electrique de Tuilière sur la Dordogne et la Distribution de l'Energie Electrique dans la Région du Sud-Ouest.* Albert Claveille. (43) May.

L'Usine Hydro-Electrique d'Andelsbuch près de Bregenz (Tyrol).* A. Bidault des Chaumes. (33) May 7.

La Stérilisation de l'Eau d'Alimentation au Moyen du Chlorure de Chaux; Installation de Montréal (Canada).* G. Dupont. (33) May 7.

Epurateurs d'Eau de Pluie.* M. Bousquet. (35) June.

Coups de Belier dans les Conduites, Résultats d'Essais et Vérification Expérimentale des Théories de M. Allièvi.* R. Neeser. (Extract from *Bul. tech. de la Suisse romande.*) (37) June 30.

Wie kann bei Schleusen mit Sparbecken der Betrieb beschleunigt werden? E. Beyerhaus. (53) May 27.

Die neuen Dreifach-Expansions-Pumpmaschinen des Hamburger Wasserwerkes.* Rud. Schröder. (48) Serial beginning May 28.

Das Rigasche Grundwasserwerk.* A. Badche. (52) Serial beginning May 31.

Die Rohrleitungen der Hydroelektrischen Anlage Kinloch-Leven. E. Liersch. (48) June 11.

Bemerkungen zur Allievischen Theorie der Druckschwankungen in Rohrleitungen.* E. Braun. (97) Serial beginning June 20.

Die Talsperre und das Ueberland Kraftwerk bei Straschin-Prangschin, Kreis Danziger Höhe. A. Behrendt und H. Bökenkamp. (48) June 25.

Der internationale Walchensee-Wettbewerb.* Theodor Koehn. (48) Serial beginning July 2.

Waterways.

Water Supply for the Lock Canal at Panama.* Julio F. Sorzano, M. Am. Soc. C. E. (54) Vol. 67.

Description of the New Harbour, Wet Dock, and Graving Dock at Avonmouth, Bristol, England, Showing the Most Modern Principles of Construction and Equipment of Docks as Adopted in Great Britain.* A. D. Swan. (5) Oct., 1909.

The Determination of Ordinary High Water Plane on the Pacific Coast of the United States.* D. E. Hughes and Otto von Geldern. (Paper read before the Tech. Soc. of the Pacific Coast.) (1) Apr.

The Chicago Harbor Problem: Report of the Committee (Western Soc. of Engrs.)* (4) Apr.

The Applications of Electricity at the Panama Canal. (73) May 13.

Method of Lining an Irrigation Canal with Cement Plaster, with a Discussion on Cement Plaster Versus Lime and Cement Plaster. W. D'Rohan. (86) May 18.

Condensed Facts on the Panama Canal. (86) May 18.

The Behavior of a Stream Carrying Sand and the Effect of Sand on the Measurement of Bottom Velocity.* E. C. Murphy. (13) May 19.

The Scoop-Wheel Pumping Plant at Schellingwonde, Holland.* Charles S. Slichter. (13) May 19.

Maximum Rate of Discharge of Streams in North-Eastern United States. (96) May 20.

The Georgian Bay Ship Canal.* (11) May 20.

A Reinforced Concrete Dock.* A. P. Brown. (14) May 21.

Some Notes on Sliding Sluice-Gates, Charles River Basin, Boston-Cambridge, Mass.* Walton H. Sears. (13) May 26.

Breakwaters at Vornpör and Hanstholm, Jutland.* (11) May 27.

Present Conditions at Panama.* (12) Serial beginning May 27.

Hydraulics of the Chagres River. Henry L. Abbot. (9) June.

The Silt Problem; Kaw River. Herman Stabler, and Horatio N. Parker. (13) June 2.

Building the Miah Maul Shoal Lighthouse.* Thomas J. Rout, Jr., and A. E. Arledge. (13) June 2.

---

* Illustrated.

Waterways—(Continued).

Experiments with a Model of the Gatun Spillway.* Edward C. Sherman, M. Am. Soc. C. E. (14) June 4.
The New York State Barge Canal.* (13) June 9.
Pontoon Method of Subaqueous Concrete Construction.* (96) June 10.
Borings for the Panama R. R. Dock at Cristobal; with Table of Costs.* E. B. Karnapp. (13) June 16.
The Stockton, California, Diverting Canal.* (14) June 18.
The Accumulation of Shore Detritus during an Off-Shore Wind. A. H. Gibson, A. M. Inst. C. E. (12) June 24.
The New Harbour Works at Constanza, Roumania.* Fr. Bock. (10) July.
The Advisability of a Waterway Improvement. George A. Zinn. (100) July.
The Emergency Gates of the Illinois and Mississippi Canal.* C. S. Riché. (100) July.
Riverside Quay, Hull.* (12) July 1.
The Erie Canal.* Charles Prelini. (11) Serial beginning July 1.
Municipal Waterfront Improvements at Oakland. (14) July 9.
An Improvement in Pier Construction, San Francisco.* (14) July 16.
Note sur les Grandes Crues de la Seine au Dix-Septième Siècle. Goupil. (43) Mar.
Note sur l'Amélioration de la Navigabilité du Rhône. Magnier. (43) Mar.
XIe Congrès International de Navigation tenu à Saint-Pétersbourg en 1908: Rapport des Délégués Français sur les Travaux du Congrès; La Navigation Intérieure en Russie.* Bourgougnon. (43) Mar.
Différents Modes d'Eclairage des Phares.* J. Bénard. (32) Mar.
Remplacement des Seuils en Bois des Passes Navigables (du Système Chanoine) de la Haute-Seine par des Seuils en Béton Armé.* Imbs. (43) May.
Nouvel Appontement en Béton Armé sur le Guadalquivir, près de Séville (Espagne).* Juan Manuel de Zafra. (33) May 14.
Dérocheuse Sous-Marine du Port de Trieste.* (33) June 4.
Vom Bau des Panama-Kanals.* Hans Raschka. (53) June 17.
Die Schleusen- und Wehranlage in der Weser bei Bremen. Oeltjen. (51) June 18.

---

* Illustrated.

Vol. XXXVI. AUGUST, 1910. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

CONTENTS

Papers:

PAGE

The Tieton Canal.
By E. G. Hopson, M. Am. Soc. C. E. 936

The Reconstruction of the Passenger Terminals at Washington, D. C.
By W. F. Strouse, M. Am. Soc. C. E. 963

The New York Tunnel Extension of the Pennsylvania Railroad: The Long Island Approaches to the East River Tunnels.
By George C. Clarke, M. Am. Soc. C. E. 1109

The New York Tunnel Extension of the Pennsylvania Railroad: The Sunnyside Yard.
By Louis H. Barker, Esq. 1150

The New York Tunnel Extension of the Pennsylvania Railroad: The Lining of the Four Permanent Shafts of the East River Division.
By F. M. Green, Assoc. M. Am. Soc. C. E. 1170

Discussions:

Pressure Resistance and Stability of Earth.
By Messrs. T. Kennard Thomson, Charles E. Gregory, Francis W. Perry, E. P. Goodrich, Francis L. Pruyn, and Frank H. Carter 1183

Reinforced Concrete Pier Construction.
By William Arthur Payne, M. Am. Soc. C. E. 1197

Memoirs:

Linus Weed Brown, M. Am. Soc. C. E. 1198
Charles Alfred Hasbrouck, M. Am. Soc. C. E. 1200
John Henderson Sample, M. Am. Soc. C. E. 1201
Albert Mather Smith, M. Am. Soc. C. E. 1202
Jacobus Van der Hoek, M. Am. Soc. C. E. 1203
Luther Elman Johnson, Jun. Am. Soc. C. E. 1205

PLATES

Plates CIII to CIX. Illustrations of the Paper entitled "The Tieton Canal" .... Pages 941 to 957
Plates CX to CXXVII. Illustrations of the Paper entitled "The Reconstruction of the Passenger Terminals at Washington, D. C." .... Pages 967 to 1101
Plates CXXVIII to CXLV. Illustrations of the Paper entitled "The New York Tunnel Extension of the Pennsylvania Railroad: The Long Island Approaches to the East River Tunnels" .... Pages 1111 to 1149
Plates CXLVI to CLVIII. Illustrations of the Paper entitled "The New York Tunnel Extension of the Pennsylvania Railroad: The Sunnyside Yard" .... Pages 1151 to 1169
Plates CLIX to CLXI. Illustrations of the Paper entitled "The New York Tunnel Extension of the Pennsylvania Railroad: The Lining of the Four Permanent Shafts of the East River Division" .... Pages 1171 to 1181

Vol. XXXVI. AUGUST, 1910. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852.

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE TIETON CANAL.

By E. G. Hopson, M. Am. Soc. C. E.

To be Presented October 5th, 1910.

The Tieton Project of the United States Reclamation Service derives its water supply from the Tieton River, in the State of Washington, one of the feeders of the Naches, the most important tributary of the Yakima. The Tieton River drains a mountainous area of about 250 sq. miles on the east slope of the Cascade Range. Its summer flow seldom falls as low as 200 sec-ft. and then only for short periods, while the maximum flood flow has been estimated at from 14 000 to 20 000 sec-ft. An extensive glacier-covered district at the summit of the mountain range furnishes the bulk of the summer flow, which is distinguished by the turbid or light green color of the water due to glacial material carried in suspension.

The Tieton Project includes some 30 000 acres, mostly of excellent semi-arid agricultural land, lying north and west of the City of North Yakima, in the basin of Cowiche Creek, requiring for its proper development an artificial supply for irrigation during the summer.

The general scheme of the irrigation system is simple, the supply being diverted from the Tieton River at a point some 14 miles above the irrigable lands and conducted in a reinforced concrete conduit or aqueduct along the Tieton Cañon to an elevation sufficient to permit

---

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

of piercing the Naches Ridge by a tunnel so as to deliver into the Cowiche Basin for distribution. The diversion of the summer flow of the Tieton River, however, necessitates the construction of compensating storage on the Naches River to satisfy vested rights on the Naches and Yakima Rivers, a reservoir of some 30 000 acre-ft. being now under construction at Bumping Lake for this purpose.

This paper describes the main canal or aqueduct along the Tieton Cañon, several novel features of design and construction likely to be of interest having been adopted on that work.

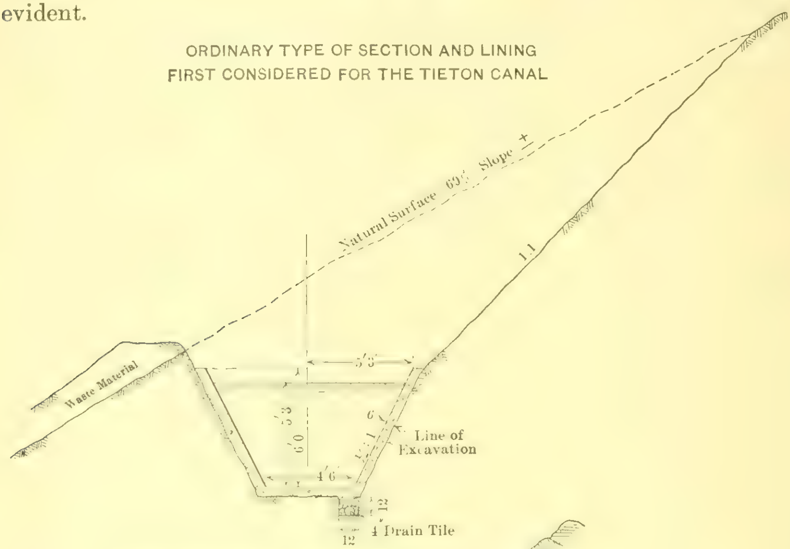
The Tieton River throughout most of its course flows in a cañon approximately 2 000 ft. in depth. The upper portions of the cañon walls are often vertical, and occasionally bluffs extend down to the stream level, but, as a general rule, the lower slopes consist of accumulated talus material, the product of erosion and disintegration, the slopes being broken here and there by bluffs or outcroppings of rock. The rock formation throughout the length of the canal is eruptive, basalts, lavas, and other volcanic matter being heaped up, intermixed and interstratified according to varied conditions of lava flow and eruptive activity during past ages.

The main canal, with a length of about 12 miles from the diversion point in the river to the lower extremity of the tunnel through the Naches Ridge, encountered practically every variety of material in its course, but at no point excepting in the extreme upper 1 000 ft. was the formation such as to permit of the use of the ordinary type of unlined earth canal.

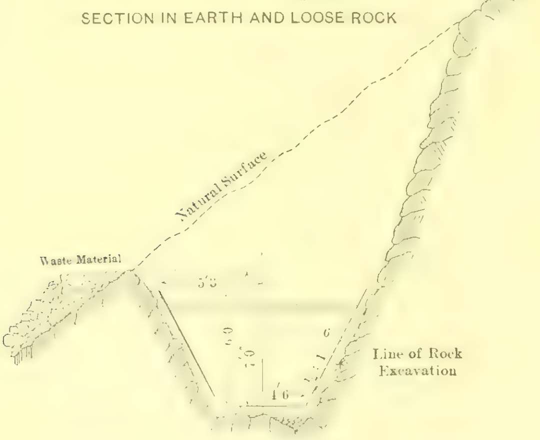
Surveys made in 1905 and 1906 disclosed the fact that the greater part of the main canal would lie on side-hill slopes averaging close to 60%, that is, with a rise of 6 to a horizontal measurement of 10. The side-hill material for the most part consisted of soils and gravelly clays frequently intermingled with slide rock material and occasionally consisting wholly of slide rock, the latter being the local term for a talus of large rock fragments. The earthy material in the side hill was found to be generally unstable during the spring, when frost was coming from the ground, and this instability was later found to be particularly noticeable in some of the slide rock material when lubricated by moisture and clay, as was frequently the case.

While originally it had been hoped that an ordinary unlined canal section in open cut might be used for much of the work, this idea soon had to be abandoned, and later it became doubtful whether even ordinary concrete lining would hold the canal intact on the steep side-hill slopes, after their tendency to cave and slide had been made evident.

ORDINARY TYPE OF SECTION AND LINING
FIRST CONSIDERED FOR THE TIETON CANAL



SECTION IN EARTH AND LOOSE ROCK



SECTION IN ROCK

FIG. 1.

Concrete lining used in canal work consists generally of from 4 to 6 in. of concrete applied to the sides and bottom of the excavated trench, as shown by Fig. 1. It had been expected that this method of construction could be used, but, as studies were elaborated and the nature of the ground was more carefully observed, grave fears were entertained as to its practicability and economy.

The completion of the final surveys in 1906 lent greater weight to these misgivings. The side-hill material *in situ* was found to be mostly at the natural angle of repose, and any considerable disturbance by undercutting the slopes, such as would be necessary for this type of construction, would result in extensive slides until a new condition of equilibrium should be reached. In the spring of 1906 the melting snows and rains had thoroughly saturated much of the upper side-hill material, and, in the light road cuts at the bottom of the cañon, it was observed that heavy sloughing and caving of a highly significant character had occurred.

Later, it was found that much of the supposedly solid rock formation was very little more stable than the earth, the material being frequently fractured and jointed in every direction, with slippery clay seams, and disintegrating rapidly on exposure to the weather.

The conclusions reached during 1906 were:

First.—That the type of canal should preferably involve as little disturbance of the natural side-hill slopes as possible;

Second.—That the canal should be a practically self-sustained structure, capable of resisting considerable external earth pressure on its upper side, and of sufficiently rigid cross-section to retain its integrity against internal hydrostatic pressures without dependence on any support from the outside embankment.

It will at once be seen, by an engineer familiar with standard flume construction in the West, that the flume type more nearly fulfills these requirements than any other, except as to external earth pressures, which do not apply, besides possessing the advantage of a low first cost. Flume construction, moreover, wholly avoids the disturbance of the natural slopes. The most unsatisfactory features of large flume construction are obviously maintenance and periodic renewal. The Reclamation Service has systematically endeavored to avoid temporary types of structures, on this account, unless conditions are such that they have an incontestable economic advantage.

In the vicinity of the Tieton Cañon the lumber most available for flume construction was yellow pine and fir. Of these, red fir was the more desirable because of its superior durability and comparative freedom from warping. It happened, however, that the local supply of red fir was insufficient for so large a work, and an adequate supply would have necessitated shipments from a distance, at high cost. It was estimated that pine used in a structure of this kind would have an average life of from 10 to 12 years, and, in addition, would require heavy annual maintenance and renewal work. Allowing for complete renewals every 10 or 15 years and necessary repair work each year, and capitalizing the first cost and necessary maintenance and repair work at 6%, it appeared that a pine flume, when thus capitalized, would be actually as costly as a permanent structure even two and one-half times as great in first cost. As a matter of fact, careful estimates showed that a well-built pine flume, properly supported on posts founded on masonry pedestals, would cost more than one-half as much as the permanent structure that has been built, so that the early abandonment of a flume design was fully justified.

The Reclamation Service, therefore, attempted to combine some of the advantages of flume construction with the more permanent types by working out a design in reinforced concrete, which alone promised to give the lateral stiffness necessary to resist both external and internal loadings, as well as to reduce the undercutting of the side-hill slopes to a minimum.

The most conspicuously practical difficulties in the way of masonry construction on the canal location were lack of concrete materials, water, and working space. Gravel and sand in any quantity could only be found at certain localities along the bottom of the cañon. Water for mixing and sprinkling would have to be taken from the river, many hundreds of feet below the canal location except at its upper end, and, moreover, the transportation of building materials and the conduct of building operations on the canal line would obviously be attended with much inconvenience on account of the steepness of the cañon walls and the narrowness of the ledge on which work must be done.

It was further apparent that reinforced canal lining capable of resisting the stresses to which it would be subjected and at the same time economical in the use of materials to the fullest extent could not be built in place advantageously on the canal location so as to insure the necessary excellence of work on a large scale; on the other hand, it was plain that first-class work in reinforced masonry could be executed in the bottom of the cañon at places where there was sufficient working space, and water and good concrete material could be had in abundance.

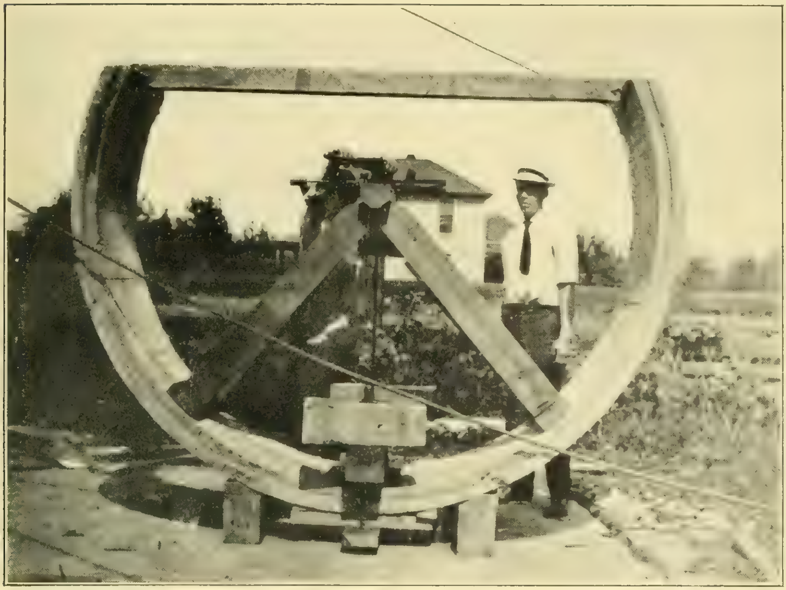


FIG. 1.—TESTING SECTION, SHOWING METHOD OF APPLYING INTERIOR PRESSURE.

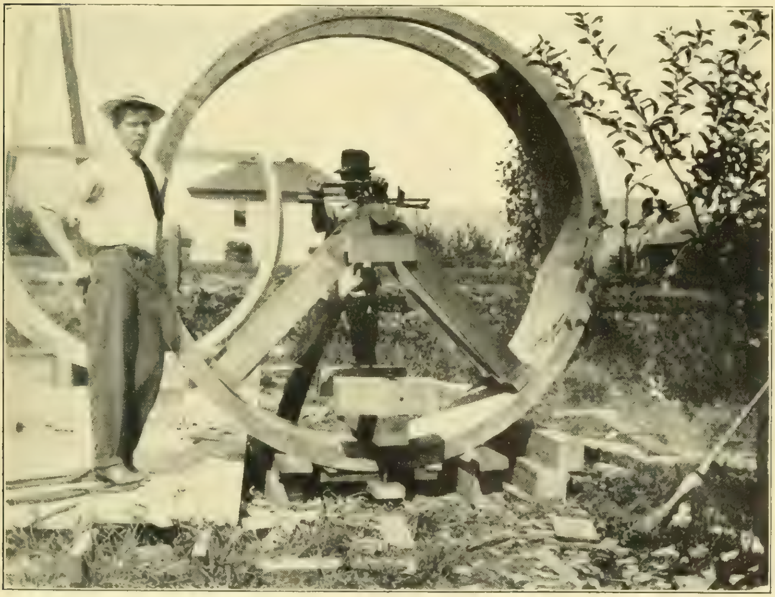


FIG. 2.—TESTING SECTION NO. 4.

The idea of building the canal in separate sections of reinforced concrete, each self-contained and sufficiently rigid to permit of transportation and handling, was therefore conceived. Accordingly, arrangements were made to utilize certain flats adjoining the river as manufacturing yards where most of the conditions suitable to successful manufacture could be found and the work could be at all times inspected systematically and rigidly.

Those familiar with building pipes and conduits in concrete will realize the advantage of moulding the concrete in forms placed so that the material can always be deposited vertically and tamped, and subject to uniform conditions and rigid inspection. These conditions existed to a marked degree in the manufacturing yards, being one of the prime considerations in the adoption of the process.

It was concluded that, if the lining could be made satisfactorily in the yards, the difficulties of handling and transportation could be overcome by careful organization and the selection of suitable plant. The most serious problems to solve, in connection with this plan of construction, were the determination as to whether reinforced concrete sections or shapes such as these would permit of handling and transportation without serious injury to themselves, whether the back-filling could be done satisfactorily so that the shapes would not subsequently settle irregularly, and whether the joints between the shapes could be made in a satisfactory way.

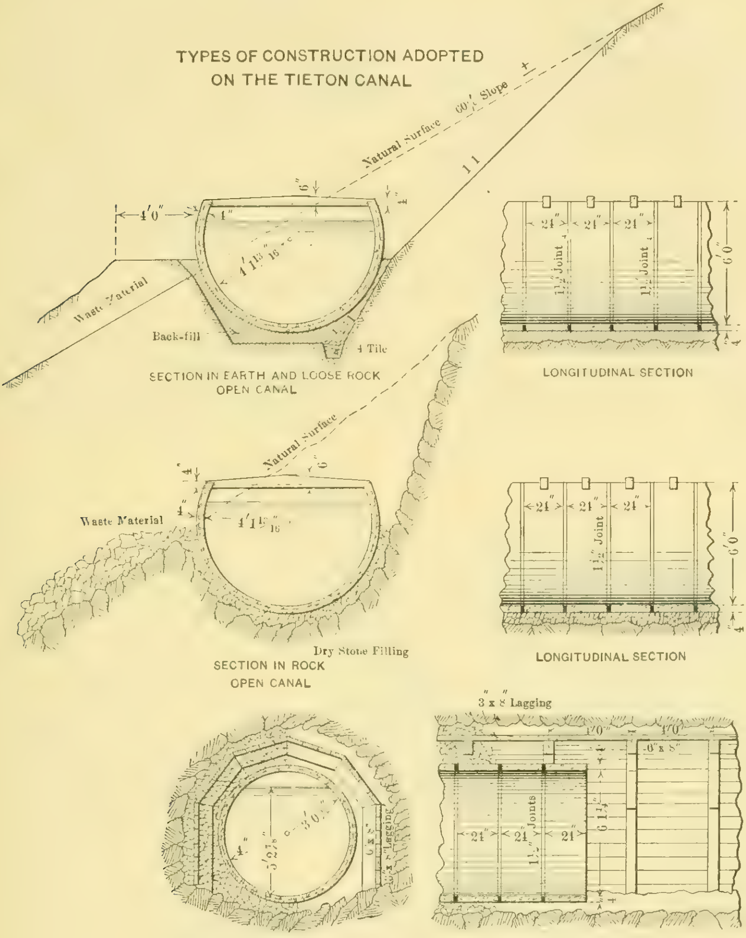
During the spring and summer of 1906 several designs were prepared for concrete shapes, and later, experimental sections were built and tested in the grounds of the local office of the Reclamation Service at North Yakima. The test sections were made of many different shapes and sizes, two of which are shown on Plate CIII. They were tested, as to their ability to stand internal stress, by a special apparatus applying internal pressures at points where the resultants of internal hydrostatic pressures with a full conduit would fall. This testing apparatus consisted of an **A**-frame set inside the concrete shape with each leg delivering pressures obtained by tightening up a tension rod passing midway between the struts and resisted by a yoke on the outside of the bottom of the shape. This device is shown by Figs. 1 and 2, Plate CIII. The pressures were registered by a special device, and were noted carefully during the period of each test, the shape itself being at the same time subjected to a close scrutiny and the development of all cracks and changes in diameters being measured and noted carefully.

The conditions to which the shapes were subjected during this test were obviously not exactly parallel to those resulting from actual field conditions, it being impossible to duplicate by mechanical means the varied stresses under working conditions. The tests, however, were in many ways much more severe than might reasonably be expected under working conditions, and in every case the pieces were tested to failure. It was found during the experiment that the shapes possessed considerable elasticity; that hair cracks developing under pressure apparently had no permanent weakening effect, and that certain sections possessed much rigidity and strength. These experimental shapes were cast in wooden forms, and, owing to the swelling of these, the reinforced concrete cross-bars were frequently cracked at the point where they joined the main body of the shape. The test pieces were weakened to a considerable extent owing to this cause. In spite of this disadvantage, however, the tests showed that, with proper care, reinforced concrete shapes such as these could be built cheaply and handled safely.

The shape that appeared to be the most satisfactory resisted internal pressures of 3 350 lb. from each strut, which was more than twice what the hydrostatic pressure would be with the canal entirely full of water. Under this pressure it was found that the horizontal diameter increased about $\frac{5}{8}$ in., which, however, was largely recovered when the pressures were removed. During the application of pressure some hair cracks could be detected on the face of the concrete under tension, but, after the pressures were relieved, they wholly disappeared. The sections were tested for external stresses due to handling in various ways, such as being dropped on a hard floor from a height of several inches, being rolled on one side, and being dropped from greater and greater heights until they were finally broken.

From data obtained during these tests it was determined that this method of construction promised satisfactory and economical results on a large scale, and final designs for open canal and tunnel sections were prepared.

Complete plans and specifications for canal construction were made, and the work was advertised for public contract, bids being opened during November, 1906. Two alternative methods of bidding on the canal construction were offered, one being to build the lining in sections, as above described, and shown by Fig. 2; and the other being by the older and standard method of depositing concrete lining in place in the canal as shown by Fig. 1. Only one bid was received, and that was based on the method of manufacturing and placing the concrete shapes as described previously.



TYPES OF CONSTRUCTION ADOPTED ON THE TIETON CANAL

SECTION IN EARTH AND LOOSE ROCK
OPEN CANAL

LONGITUDINAL SECTION

SECTION IN ROCK
OPEN CANAL

LONGITUDINAL SECTION

TUNNEL SECTION IN UNSOUND ROCK

LONGITUDINAL SECTION

FIG. 2.

A contract for manufacturing and laying concrete shapes was awarded, and work was started during 1907. After little more than a start had been made by the contractor, the plant and work were taken over by the Reclamation Service, and the work was carried to completion in the fall of 1909, all work being done by force account under the direction of the engineers of the Service.

Fig. 2 shows the typical cross-sections of open canal work and tunnel work as constructed. The sections or shapes in which the lining was manufactured are of uniform length (measured along the canal) of 2 ft., both for open canal and tunnel work. Each shape consisted of a slab of reinforced concrete, 4 in. in thickness, moulded to the desired shape. The reinforcement consisted of $\frac{3}{8}$-in. corrugated rods placed 4 in. from center to center. Each open canal shape was stiffened by a 4 by 6-in. cross-bar, which had for reinforcement two $\frac{3}{8}$-in. corrugated rods. The tunnel shapes were completely cylindrical. The concrete in these shapes was generally composed of 1 part of cement to 10 parts of unmixed aggregates, the latter being proportioned so as to give a mixture as dense as possible. The shapes were all cast on their sides in steel moulds. The moulds were made of thin sheet-steel, riveted to steel angles, and stiffened with suitable bracing of light angle iron. The moulds for the open canal were made in four pieces, two inside and two outside. All tunnel moulds were made in six pieces, of similar construction. All parts were light, the heaviest being handled easily by two men. The method of construction may be briefly described as follows:

At points along the bottom of the cañon, level spaces, each of a few acres in extent, were selected and used as yards for manufacturing the shapes. These spaces were necessarily of small area, being practically all the space available, the cañon being generally a mere gorge. At some of these points concrete material was at hand, but at others it had to be hauled from a distance. All open canal and tunnel lining shapes were cast at these yards, the process being continued until each yard was filled, or the necessary number of shapes were cast. Whenever the yards were sufficiently large so that storage could be had to enable the first shapes cast to be cured and hardened properly, a process requiring 30 days, before the yard was entirely filled, the manufacture of new shapes and the removal of the finished product took place simultaneously, so that at one end of the yard new shapes were being made, while at the other end shapes were being loaded on cars and hauled away, this being continued until all lining appurtenant to that yard had been completed. At other points, where space was limited, a yard would be filled with shapes which would then be left

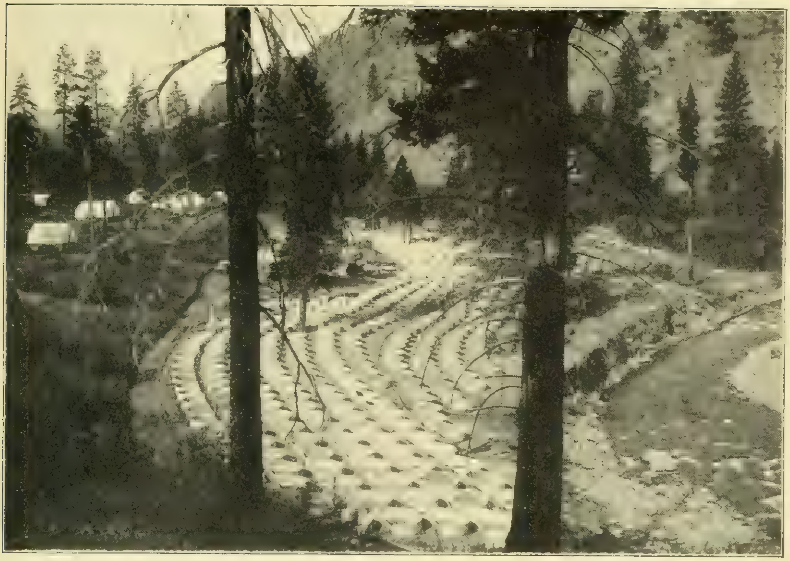


FIG. 1.—YARD FILLED WITH CANAL SHAPES.

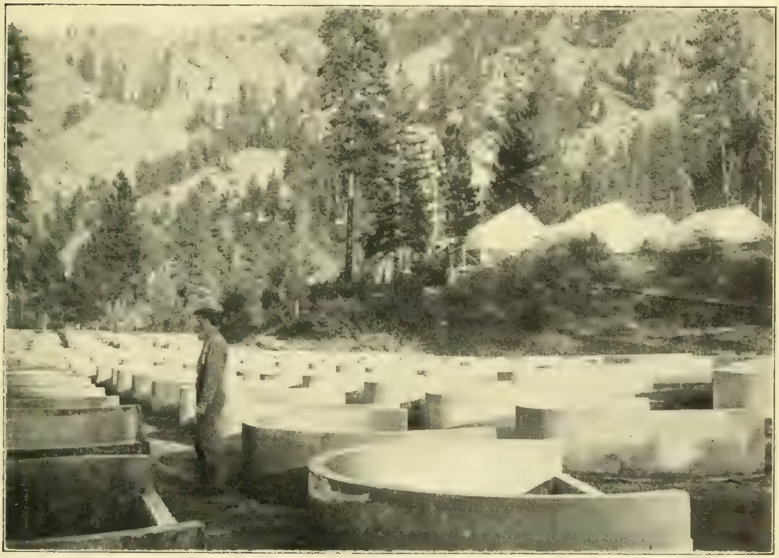


FIG. 2.—YARD FILLED WITH CANAL SHAPES.

to harden while work started at some other point. Yards filled with finished shapes are shown on Plate CIV.

All mixing was done in cubical batch mixers, each batch exactly filling a mould, the open canal shapes containing about 0.47 cu. yd., and the tunnel shapes about 0.50 cu. yd. All the aggregates were screened by rotary screens and segregated into two grades of gravel and one of sand, the coarsest gravel used passing a 2½-in. mesh. All material was obtained from the river bed or adjacent bars, passed through a crusher, and screened, the coarser fragments being returned to the crusher. A very wet mix was used.

The yards for manufacturing were first cleared of obstructions, such as large rocks, fallen logs, etc., and, if necessary, roughly leveled and staked out preparatory to placing the forms or moulds in position. In placing the moulds, the inside forms were first set up over a portable templet and bolted firmly together, so that all shapes should have exactly the same inside dimensions by being fitted to the same templet. Fig. 1, Plate CV, shows a portable templet and the method of setting up the inside forms. The latter, when bolted together, were then laid in their correct position on the ground, being supported by small wood blocks; the outside forms were then placed in position, spaced 4 in. outside of the inner forms, and held there by wooden blocking and iron clamps. The next step was to prepare a firm and correctly moulded base on which to tamp the concrete in the moulds. This was obtained with a preparation of sand and plaster of Paris worked to the consistency of mortar and tamped to a thickness of about 1 in. in the bottom of the mould. The top of this plaster was readily brought to a smooth, even surface by metal moulding irons. The plaster of Paris quickly hardened into a tough plastic mass, which wholly closed the bottom of the mould and gave an even bed on which to ram the concrete; it also prevented the leakage of the finer portions of the concrete material.

A regular gang in each yard attended to the setting up and removal of the forms and their subsequent cleaning and transportation to other localities, also to the preparation of the plaster of Paris bases. This gang acquired much dexterity by constant repetition of the same process, which had to be performed many thousand times during the work. Frequently, keen rivalry existed between the gangs in different yards as to how many forms could be set up in place in a given time.

After being set up, all forms were carefully oiled on the surfaces with which the concrete would come in contact. After the bases had hardened sufficiently, the concrete-placing gang performed its share of the process, a batch of concrete being hauled from the mixer to each shape in turn in an ordinary bottom-dumping car, the material being dumped into a vat placed next to the form to be filled. The mixture was immediately shoveled into the mould, the steel reinforcement being placed at intervals of 4 in. as the mould was gradually filled. The reinforcement was held in place during the process with spacing bars of proper width, which were withdrawn as the concrete gradually filled the mould. The mould when filled was left for a short time for the concrete to settle, it being usually found that a settlement of about ½ in. to 1 in. would take place as the material gradually consolidated and air bubbles escaped. Before the initial set had taken place, however, the shape was finished by troweling off the top surface evenly with mortar and moulding it with a special moulding iron so as to form a depression around its upper edge for jointing purposes.

The process of setting up forms and placing concrete and steel was performed with remarkable expedition and by a comparatively small number of men, considering the large variety of special parts to be handled. The regular gang for setting up and handling the forms and preparing the bases consisted generally of one foreman and 10 men. This gang would set up generally about 80 to 100 forms per day at an average cost of a little more than 50 cents per form, or equivalent to about $2.20 per cu. yd. of concrete. The average cost of excavating, handling, crushing, and screening the concrete aggregates was about $1.50 per cu. yd. of concrete. The cost of mixing and delivering the concrete to the moulds was about 70 cents per cu. yd. The cost of placing concrete in the moulds, including the handling and placing of steel reinforcement, was about 65 cents per cu. yd. In other words, the total labor cost for the finished concrete in the moulds was about $5.05 per cu. yd. The cost of plant and supplies added about $3.20 to this figure, the latter including the cost of all steel forms, mixers, crushers, pipes, pumps, teams, and wagons used in connection with making the concrete for the open canal shapes. The total cost, therefore, for labor, supplies, and plant for this concrete was about $8.25 per cu. yd.

The concrete shapes after being cast were left undisturbed for intervals of from 24 to 36 hours before the forms were removed. During

PLATE CV.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
HOPSON ON
THE TIETON CANAL.

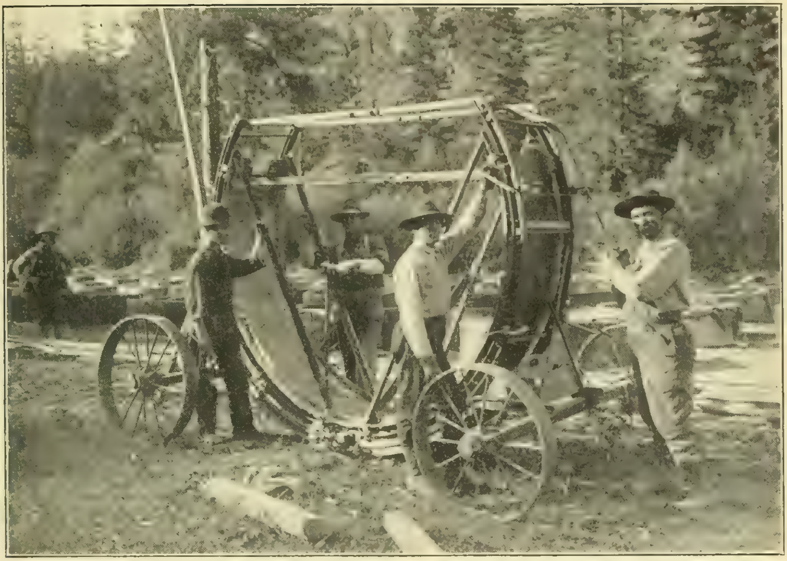


Fig. 1.—Portable Templet for Setting Up Moulds.

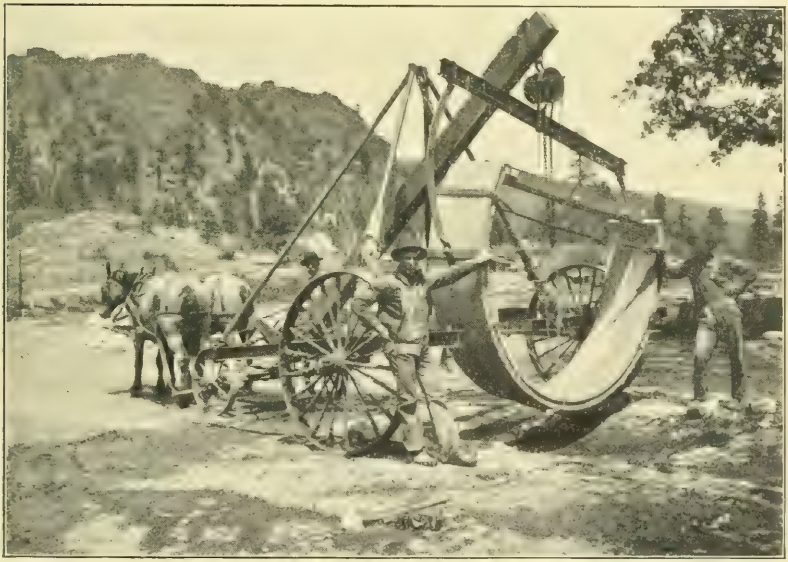


Fig. 2.—Raising and Hauling Canal Shape in Yard.

the colder weather this period was sometimes extended to two or three days. At these times the top and exposed surfaces of the moulds were covered with wet gunny-sacks to prevent the occurrence of sun cracks in the concrete. The moulds were then removed simply by collapsing the inside centers, after removing the interior bracing, and then peeling off the outside forms, after unbolting them. The reinforced cross-bars in the open canal shapes were left with their bottom form, which consisted of a 1½-in. pine plank, in place, supported in its middle by a small wooden prop. The forms were stripped by a trained gang in a very systematic and expeditious way. Each part of the removed form was carefully laid aside for reassembling, and afterward cleaned, oiled, repaired as required, and transported to a fresh location to be used again.

The concrete when stripped invariably had clean, smooth surfaces with sharp edges and good color. Immediately after stripping, the concrete was covered with gunny-sacks or canvas and sprinkled continuously for a period of about 10 days in the warm weather. For this purpose a complete system of piping, hose, and pumps had been established in each yard, and the water was delivered from the nozzles under a good pressure, thus making the sprinkling effective. In the larger yards as many as two or three men were continuously sprinkling the concrete; this proved to be one of the most difficult parts of the process to execute in a satisfactory way, owing to the large areas over which the yards extended. In spite of all precautions and vigilance, it appeared that this portion of the work was perhaps executed in the least satisfactory way. From time to time, however, tests were made of the comparative qualities of the concrete cured in the yards, and apparently it was not appreciably inferior in strength or toughness to samples of concrete kept continually immersed in water.

The cost of wetting and finishing the concrete for open canal shapes was about $1.00 per cu. yd., thus bringing the cost of concrete up to $9.25 per cu. yd. for labor, plant, and supplies for the completed shape, or about $4.10 for each shape measuring 2 ft. along the canal line, or equivalent to a little more than $2.00 per lin. ft. of canal lining for the open canal.

About 35 lb. of steel was used for each shape, and about ½ bbl. of cement, each costing about $2.10 and $1.50, respectively; so that the final cost of the concrete in the open canal shapes when completed and lying in the yard ready for transportation to the canal, including the cost of cement and steel, was about $8.00 per shape, or $4.00 per ft. of canal lining, or, if reduced to a yardage basis, equal to about $17.00 per cu. yd.

The costs of tunnel lining were somewhat higher than the above, largely due to the fact that the plant charges for tunnel were more than for open canal work, as there was a smaller quantity of tunnel lining to build, so that the distributed plant costs were higher. The final cost of labor, plant, and supplies in 1908 for tunnel lining was about $11.50 per cu. yd. of concrete. The gross cost, including cement and steel, was about $19.00 per cu. yd., or about $9.50 per individual shape 2 ft. long, or $4.75 per lin. ft. of tunnel lining.

The foregoing figures for the costs were obtained about the end of 1908, after about one-half the work was completed and the more serious initial difficulties of construction had been overcome. Administration and engineering charges are included, averaging in amount about 13%, inclusive of the cost of building a wagon road, described later.

The shapes were permitted to lie in the yards for a period of not less than 30 days, after which they were raised from their beds and hauled to the point where they were loaded on special cars for delivery to the canal. The process of raising and hauling is shown by Fig. 2, Plate CV.

Before leaving the yard, all sand and plaster of Paris that might be still adhering to the bottom edges of the shapes was removed. This required only a few moments' application of a wire brush. The shape was then lifted with a differential block and loaded on a special steel car shown by Fig. 1, Plate CVI. The loaded car was then pushed on a siding ready for transportation to the canal.

From each yard inclined hoists driven by electric motors, or cableways similarly operated, were used to deliver the loaded shapes to the canal location. Sometimes as many as two or three cars were hoisted at a time, depending on the length and steepness of the incline. The loaded cars when delivered at the canal location were made up into trains of four or five cars and hauled by horse along a temporary track laid in the canal bed to the point where laying operations were in progress. Fig. 1, Plate CVI, shows a train of cars containing open canal shapes being hauled along the canal. Sidings at suitable intervals permitted the passage of empty return cars. Transportation was thus reduced to a simple and economical process, the labor cost of

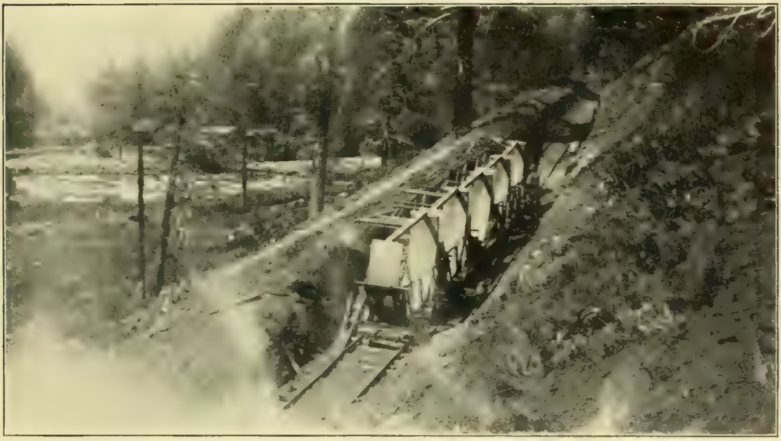


FIG. 1.—TRAIN OF SPECIAL CARS LOADED WITH CANAL SHAPES.

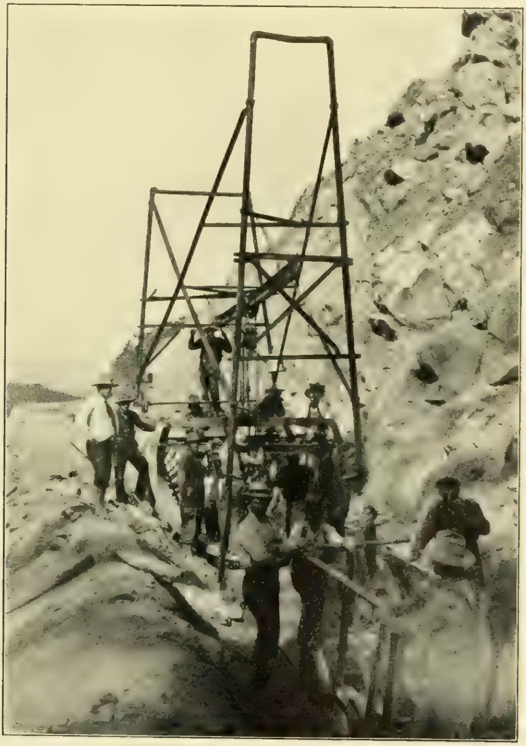


FIG. 2.—SPECIAL DEVICE FOR PLACING SHAPES IN CANAL BED.

transporting and handling the shapes from the yard to the canal and hauling along the canal being about 33 cents per ft. of lining.

The loaded train of cars was stopped at the siding nearest to the point where shape-laying was in progress, each full car as required being individually run forward to be unloaded; the empty cars were shunted to the main track for final return to the yard.

A special device was used for unloading the shapes from the cars, and handling and placing them in final position in the canal. This device, shown by Fig. 2, Plate CVI, consisted essentially of a braced frame of 3-in. iron pipe supporting an overhead I-beam running longitudinally to the canal, directly over the spot where the cars delivered their loads. On the I-beam there was a small trolley carrying a differential block. From the differential block was suspended the newly delivered concrete shape, and the trolley permitted longitudinal adjustment. Lateral adjustment was obtained by a device permitting the overhead I-beam to be swung from one side of the canal to the other as required. The delivered shape was suspended from the differential block by a yoke fitting to the inside of the shape.

The shape when delivered was first swung from the car by the differential pulley, the empty car being immediately run back. The shape, hanging from the block and overhead trolley, was then run along the I-beam to its correct position in the trench, all lines and grades having been taken in advance so that final adjustment could be made without the loss of more than a few moments. Various ingenious devices were elaborated by the trained crews who performed this laying work, so that the shape when once adjusted in position was firmly held by clamps and blocks prior to the deposition of the back-filling.

The process of delivering and setting these shapes was a very interesting one, the gangs being thoroughly drilled and each man an expert in his line of work. As each open shape weighed about 1 800 lb., engineers familiar with the placing of heavy masses will realize the difficulty of adjusting them accurately and speedily. Adjustment for each shape had to be made for line and level, both laterally and longitudinally. When adjusted in position and carefully blocked, the shape was at once back-filled, the space between the bottom of the concrete shape and the canal bed being from 4 to 6 in. The back-filling material was shoveled into this space from the end, each shovelful being tamped with long iron rammers to such hardness that the shape generally began to be raised from its bed by the pressure of the rammed material before the ramming was discontinued. A great deal of attention was given to the thorough tamping of the back-filling directly under the shape so that there should be no danger of subsequent settlement. The back-filling for a width of about 6 ft. under the shapes, therefore, was watched very carefully, and only selected material was used for this purpose, all material of a loamy nature being excluded.

The back-filling around the sides of the shapes was not done with the extreme care used in the other portions, the material being shoveled in from the top and rammed every foot or two in depth by hand rammers. A space about 1½ in. in width, between the concrete shapes was left for the jointing, to be performed subsequently.

The laying gang, consisting of an inspector, a foreman, and eight laborers, laid on an average from forty to fifty shapes per day in open canal work, or a total of from 80 to 100 ft. of canal lining. The cost of labor in handling and placing the shapes was about 47 cents per lin. ft. of lining, this price including the cost of all back-filling.

On sharp curves shapes moulded a little narrower on one side than on the other were inserted, but when the curves were of large radius no specially moulded shapes were used, the curve being entirely taken up by the joints.

The jointing, the last process, was carried on as far as possible during the early mornings and the cooler weather so that the concrete would be at the lowest possible temperature at the time the joints were made. During this process the portion of the canal being jointed was covered with canvas to exclude the direct rays of the sun and to keep the temperature low, the canvas being generally kept wet so that the temperature would be lowered by evaporation.

The joints were made of concrete of a fine aggregate, the stones passing a ½-in. mesh. The joint was well filled, but before the concrete had acquired its set, the surface of the joint in the interior of the canal was scraped off and a finish coat of mortar was troweled on, so that the finished surface of the joint was exactly flush with the surfaces of the adjacent shapes. The width of the joints permitted any small irregularity, due to the placing of the shapes or to the dimensions of the shapes themselves, to be taken up without any jog in the interior of the canal. The result of this jointing work has been in general very satisfactory, the interior of the canal having a remarkably smooth and even surface.

The joints after completion were kept well wet until the concrete had hardened, and whenever practicable the canal after being jointed was kept full of water, so that the joints were hardened under the best conditions.

Up to the end of 1908 the average cost of placing about 13 000 ft. of open canal shapes, including removal from the yards, transporting, placing, and back-filling in the trench, was about $1.30 per lin. ft. of canal lining, or $2.60 per shape. The cost of jointing about 5 000 ft. of lining was found to average about $1.00 per joint, or 50 cents per ft. The gross cost, therefore, of the concrete lining in place, including all plant and general charges, engineering, and administration, but excluding any canal excavation or preparation of the canal bed, was about $5.80 per ft. A finished portion of the open canal is shown by Fig. 1, Plate CVII.

All long tunnels on the canal except one (the Trail Creek Tunnel) were lined with reinforced concrete shapes built in rings 2 ft. in length. There were three of these tunnels having an aggregate length of about 8 000 ft. All were driven through lavas and basaltic formations, and, for the greater part of their length, timbering was required, even for temporary support. The tunnel lining was cast in yards in the same manner as the open canal lining, and the shapes were finally delivered in the tunnel on small cars. These cars were specially designed for lightness and compactness, so that the empties could be readily lifted from the track and stacked temporarily in the tunnel pending their return to the yards, without interference with the delivery of the loaded cars.

As in the case of the open canal shapes, special mechanical devices were used for handling the completed shapes at the point where laying operations were in progress, and thereafter holding them in place during back-filling. The device consisted essentially of a steel I-beam supported on rollers and braced to the bottom and sides of the completed work. The delivered shape was supported by a yoke fitting inside of it and running on a trolley along the I-beam, by which it could be readily run into position. The supporting I-beam permitted all vertical and lateral adjustment and held the shape in position during the process of back-filling in spite of its great weight and the cramped quarters in which the men worked.

The back-filling was rammed into position as soon as each shape was accurately adjusted. In cases where there were large cavities over the roof or in the haunches, requiring excessive quantities of back-filling, pine logs and blocking were used as fillers to a considerable extent. All back-filling on the bottom and sides, however, was made with fragments of hard rock.

The jointing was done subsequently in the manner described for the open canal work, the devices used being, of course, modified to suit the different conditions of the tunnel work. By constant drilling and practice the men were able to lay the shapes in the tunnel in a very expeditious and satisfactory manner. Alignment and grades were always scrupulously kept, and the back-filling could readily be made subject to constant and vigilant inspection. It may be remarked here that this method of lining for small tunnels has proved very successful, both from economic and qualitative standpoints.

The tunnel which was not lined by this method was driven through about 3 200 ft. of very hard and firm basalt, and, as there seemed to be no necessity for a permanent arch for the roof, it was decided to omit it, in general, and build concrete lining in place by the usual methods. It was found, however, that the actual cost of lining and back-filling, which in this case included only the side-walls and invert, exceeded the cost of the complete circular lining by the shape method as previously described. This was due principally to the excessive quantities of concrete required to fill holes and cavities in the sides caused by irregularities in blasting the tunnel. The method of tunnel lining by shapes is advantageous inasmuch as the costly masonry lining is kept to a minimum impossible to attain with the older method. The principal advantage of the method of building lining by shapes, however, is that first-class work can be assured with greater certainty than by the standard method, all masonry being built in the open, and subject to rigid inspection; the placing and back-filling are also carried out under much better control than is possible under ordinary conditions of tunnel work. The experience derived from lining the tunnels for the Tieton Canal has demonstrated that this method of tunnel lining can be readily used wherever tunnels of moderate dimensions require treatment.

The cost of tunnel lining in the yard at the end of 1908 was about $4.75 per ft. of completed shapes. The cost of transporting, laying, back-filling, and jointing tunnel shapes was found to approximate

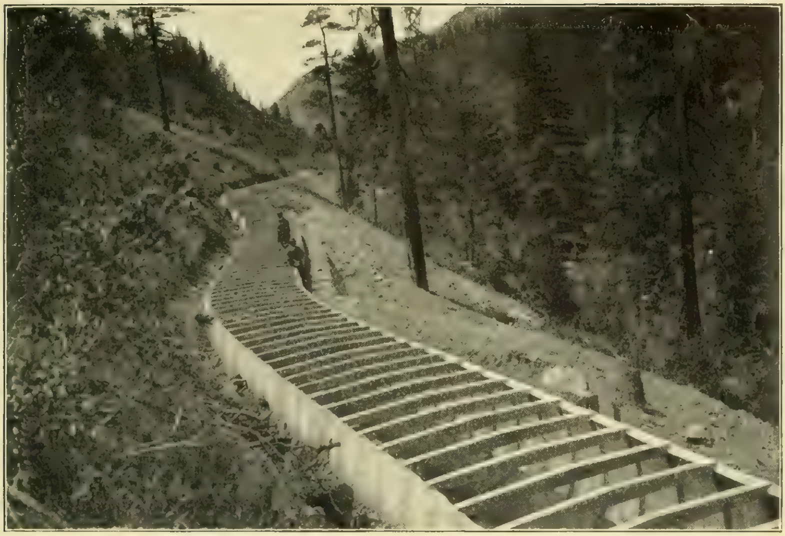


FIG. 1.—A FINISHED PORTION OF OPEN CANAL.

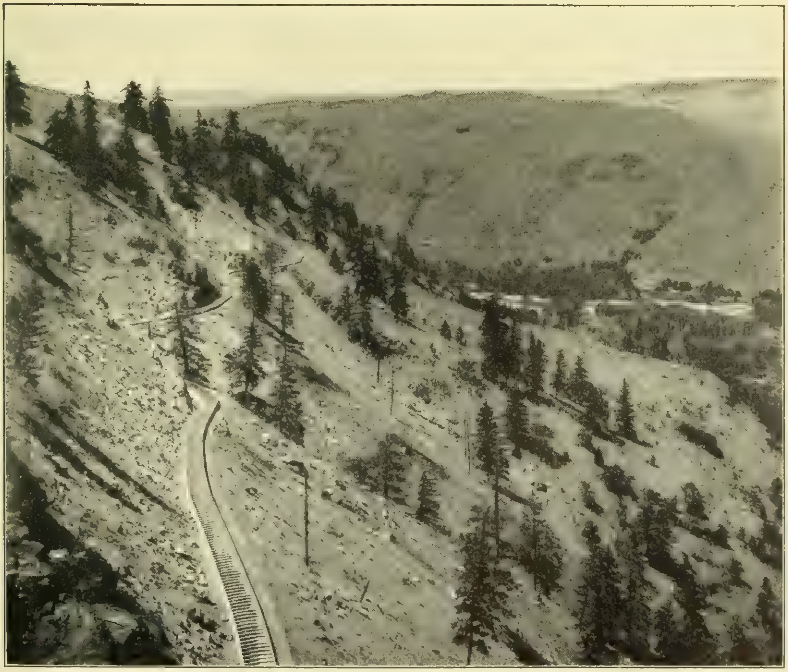


FIG. 2.—PART OF ALIGNMENT OF CANAL.

$3.60 per lin. ft., so that the completed tunnel lining in place, including all plant and operation charges, but not including any excavation or timbering, was approximately $8.35 per lin. ft.

The other principal feature of canal construction was the excavation for the open canals and tunnels. All tunnels, except one short one, were built by force account, that is, by a force organized and operated by the engineers of the Reclamation Service. The aggregate length of tunnels thus built was about 10 000 ft. There were no noteworthy features connected with this tunnel work, except that costs were generally kept down to a satisfactory figure, in spite of the difficult nature of the material encountered, and the entire work was completed without any serious mishap.

The two lower tunnels, called the Tieton and North Fork Tunnels, respectively 2 900 and 3 000 ft. in length, were driven by compressed-air drills of the ordinary type, the compressor being located in the bottom of the cañon, midway between the tunnels. Tunnel operations were generally carried out in two 8-hour shifts per day, although the arrangements of the shifts was frequently altered to meet changing conditions. The cost of driving these two tunnels, including all material for plant, up to the end of 1908, when the greater portions were completed, was about $19.00 per ft. It may be of interest to know that these figures represent actual costs of tunnel work during a period when labor was abnormally high and difficult to obtain and hold, the work being also at a remote location where all material and supplies had to be hauled from a considerable distance.

The following are the details of the cost of tunnel driving for the North Fork and Tieton Tunnels:

	Per linear foot.
Labor in tunnel	$8.00
Explosives	1.50
Supplies	0.50
Power-plant operation	1.10
Blacksmith shop	0.75
Timbering	2.50
Plant charges	5.00
Total	$19.35

The above costs include engineering and administrative charges. The inside dimensions of these tunnels, as excavated in the rock, were approximately 8 by 8 ft.

The third long tunnel, the Trail Creek Tunnel, was driven for almost its entire length through an unusually hard blue basalt. The driving was effected at first by electric drills operated by three-phase, 60-cycle, 220-volt alternating current. As the work progressed, continual trouble was caused by breakage of parts of these drills, the springs operating the rebound being particularly susceptible to injury. Duplicate parts could only be obtained after much delay. In addition, there was much difficulty on account of labor, it being found practically impossible to obtain drillmen skilled in the use of electric drills. Ordinary drillmen would generally refuse to use the apparatus, or, if persuaded to make a trial, would obviously use it in an unsympathetic and ineffective way. Careful study, however, of the effectiveness of the electric drills, even when skillfully handled, showed that in very hard rock they were uneconomical, their penetrative power being low. Eventually, Temple-Ingersoll drills were substituted, and the work was completed with them. These drills are practically air drills driven by an electrically-operated air pump on a small truck. This apparatus was found to be much more effective than the electric drills for which they had been substituted, the blows being much more forcible and the penetration correspondingly more economical. This apparatus, moreover, was found to be far less subject to injury than the electric drills.

The cost of driving the Trail Creek Tunnel proved to be much higher than that of the other two tunnels, the corresponding figures for tunnel excavation being about $20 per lin. ft., in spite of the fact that little or no timbering was required.

Excavation in the open canal, that is, the preparation of a bed for the concrete shapes, was also attended with considerable difficulty because of the location of the canal, the steep slopes, and the numerous side gullies and gorges which broke the continuity of the side-hills and required special treatment. The line was located so as to reduce the excavation to a minimum and also so that there should be the minimum disturbance of the natural slopes of the hillside. The natural slopes, however, were frequently so steep that a 1½ to 1 slope on the upper side of the canal excavation would only intersect them at a considerable distance above the canal line, so that, even with the shallow cut required for this type of construction, a large quantity of material had to be removed.

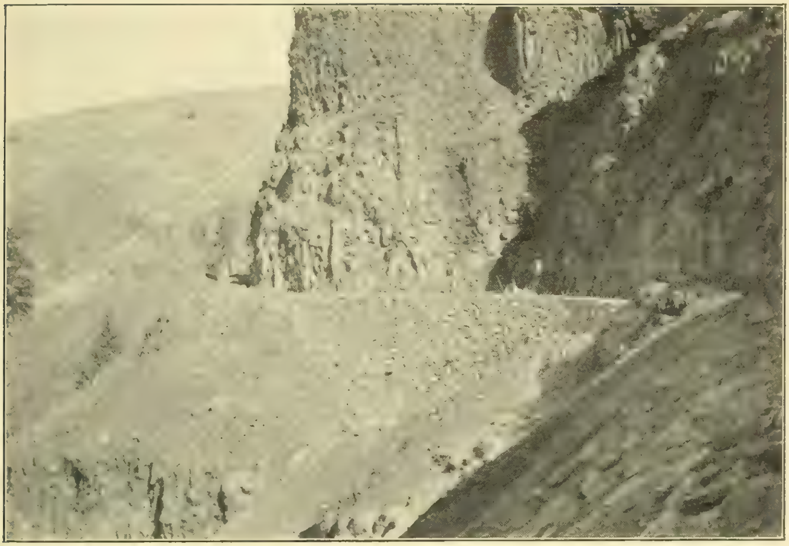


FIG. 1.—DRY RUBBLE EMBANKMENT AT CROSSING OF GULLY.

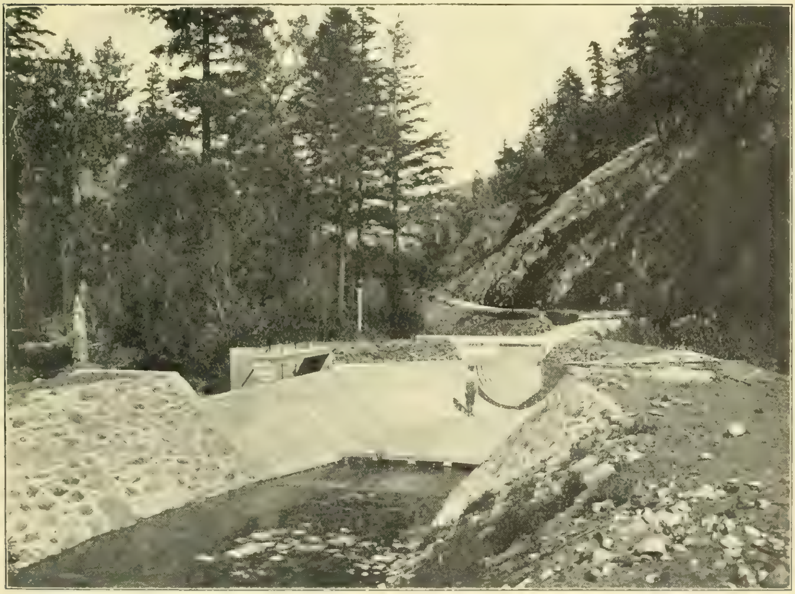


FIG. 2.—SAND GATE AT UPPER END OF LINED CANAL.

Practically all excavation was by hand, the steepness of the hillside not permitting the use of animals or mechanical methods. Much of the excavation was in rock. The average cost of excavation per cubic yard up to the end of 1908 was about 65 cents, inclusive of both earth and rock. It is probable that about 30% of the entire work was in solid or loose rock. Wherever the canal location was in earth, a 4-in. drain tile was laid along the bottom of the trench on the side toward the hill, outlets for the drain being built at intervals of from 300 to 500 ft. This drain was for the purpose of taking care of natural ground-water, or seepage water from the canal, and preventing its accumulation and consequent tendency to soften the bed of the reinforced lining.

All deep gullies on the line of the canal were crossed on dry rubble embankments, and, where necessary, masonry culverts were built at the bottom of these. Fig. 1, Plate CVIII, shows the method of crossing one of these gullies on a rubble embankment. At certain points large jutting shoulders of rock necessitated short tunnels, 100 or 200 ft. in length, and in such cases the tunnels were driven of sufficiently large section to permit of laying open canal shapes continuously through them, thus making no break in the continuity of the open canal.

The diversion dam on the Tieton River is a low overflow weir of concrete, heavily protected with rock paving and founded on a rock-filled timber crib. The head-gates are set in masonry built into the ledge. All this work is particularly solid and permanent, but does not need special description in this paper.

Immediately below the head-gates, the canal is in open unlined earth cut for about 1 000 ft., being practically in the bottom of the cañon. The material is heavy gravel and cobbles, and the canal is well protected from the river. At the lower end of this unlined channel there is a special structure intended to exclude sand from the lined canal. At this point the water flows over a low masonry lip, beneath which are small channels leading directly into the river through lines of vitrified pipe. Sand being carried in suspension along the bottom of the canal, will at this point pass under the lip and be returned to the river. Fig. 2, Plate CVIII, shows this structure (called the sand-gate) and also the upper end of the lined canal, which, from this point, is lined with reinforced concrete for about 12 miles. The transition of open canal to tunnel at one point is shown by Fig. 1, Plate CIX.

The gradient of the open canal is 0.00165, or 8.71 ft. per mile. The inside diameter of the reinforced lining is 8 ft. 3⅝ in., and the distance from the bottom of the cross-bar to the invert is 6 ft.

The canal at its capacity is designed to flow 5 ft. 3 in. in depth, leaving a clearance of 9 in. under the cross-bars. The area of cross-section of the flowing stream, therefore, is 36.01 sq. ft. It was estimated that the lining would have a coefficient of roughness of 0.012 in Kutter's formula, and the resulting velocity would be 9.05 ft. per sec., with a discharge of 326 sec-ft. The canal being intended to carry 300 sec-ft., it was considered that the additional allowance of 26 sec-ft. was justifiable as a margin of safety to provide for possible subsequent increase in frictional resistance due to organic growth within the conduit, or perhaps to roughening of the interior surface.

The gradient of the tunnels is 0.0045, or 23.9 ft. per mile. The finished inside of the tunnels, excepting the Trail Creek Tunnel, is circular in shape, with a diameter of 6 ft. 1¼ in. The depth of flowing water in the tunnel at the canal capacity was estimated at 5 ft. 3 in., leaving a maximum clearance of about 10 in. The sectional area of the flowing stream was estimated at 26.55 sq. ft., the coefficient of roughness being estimated at the same figure as considered for the open canal. The estimated velocity was 12.65 ft. per sec., with a discharge of 336 sec-ft., it being intended to leave a somewhat higher margin of safety than in the case of the open canal.

The alignment of the open canal had frequently to be very tortuous on account of the topography of the side hills, as shown by Fig. 2, Plate CVII. The maximum curves had a radius of 50 ft., and at certain points it was necessary to have reversals, even with this extreme curvature. The tunnels were built without curvature. An actual test of the hydraulic efficiency of the canal was awaited with much interest, some doubt being entertained as to whether the completed canal would justify anticipations as to its delivery. Measurements of flow made in a concrete-lined canal in Oregon early in 1909 appeared to indicate that heavy losses of head due to sharp curvature might be expected, and, moreover, the retarding effect of the innumerable transverse joints between the concrete shapes in the Tieton Canal was an entirely unknown factor. The canal was completed in the fall of 1909, but the upper few miles were subjected to hydraulic test during July of the same year.

PLATE CIX.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
HOPSON ON
THE TIETON CANAL.

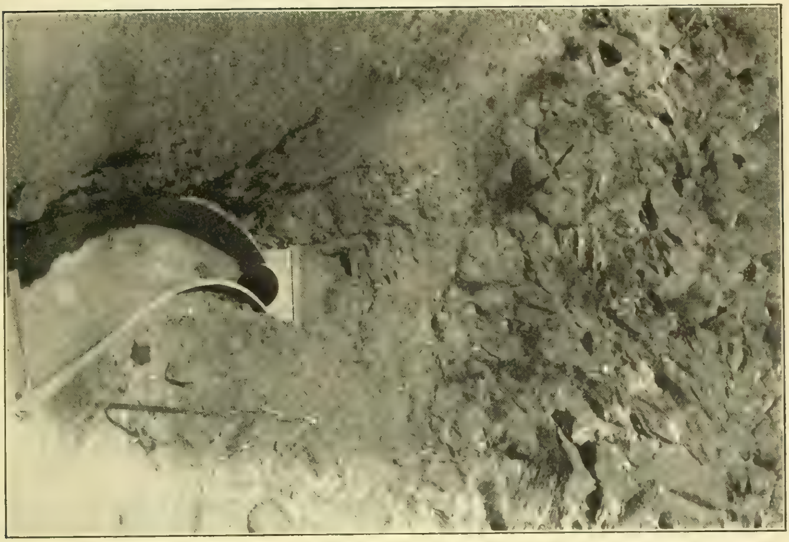


FIG. 1.—TRANSITION FROM OPEN CANAL TO TUNNEL.

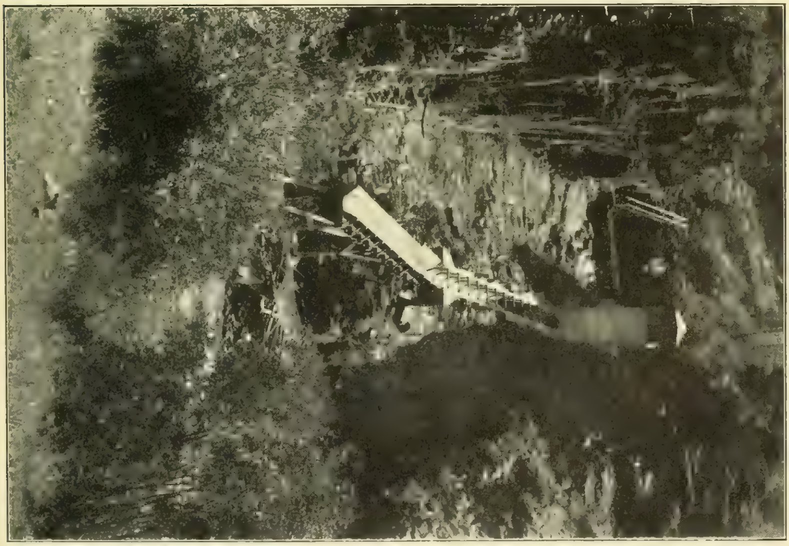


FIG. 2.—EMERGENCY WASTEWAY.

During this test the quantities flowing were measured in the unlined section of the canal between the head-works and the sand-gates, where the velocity is low, measurement being taken by careful current meter gaugings. The maximum quantity measured was 274 sec-ft., the water being wasted at one of the emergency wasteways about 2½ miles below the sand-gates, shown by Fig. 2, Plate CIX. This portion of the lined canal was the first to be built, and the grades and alignment were not as well kept as in the portions built later. The first reinforced shapes that were manufactured were also placed in this part of the work, and in many respects these shapes were inferior in quality to those made later, as experience and skill in the operative force developed. Therefore it was reasonable to expect that the hydraulic qualities of this part of the canal might be somewhat inferior to those of the other portions.

During the tests the quantity of water flowing was measured continuously below the head-gates, and measurements down to the surface of the flowing water were taken at various points in the canal. There was much difficulty in taking the latter measurements with any accuracy owing to high velocity and erratic wave action. Precise measurements of this kind, however, have little significance, save to establish the mean depth of the flowing water. The average of a number of readings showed that, with 274 sec-ft. of water flowing, the mean depth in the lined canal was 4 ft. 7 in., or 8 in. less than the estimated depth at full capacity. This shows that the equivalent of Kutter's n would be almost exactly 0.012, which is the estimated figure.

The following observations are quoted from the statement of J. S. Conway, Assoc. M. Am. Soc. C. E., Engineer in Charge:

"The flow through the lined section was replete with anomalies, and did not seem to obey any of the common hydraulic laws. There were a number of points where the water was heaped up and thrown into considerable turmoil without any apparent cause. These points * * * occurred at regular intervals, regardless of curves or tangents, and, in fact, were somewhat more noticeable on long tangents than in other places. In addition, there were traveling surges of water which worked their way slowly down the canal, causing irregularity of about 6 in. in depth from a given point. There were also quickly changing high and low points varying between a few tenths (in height) which seemed to travel with the water. There were places where the depth was not over

3 ft. for a stretch of 50 to 75 ft., and other places of similar length where the depth was 5 ft. or over. With the exception of the extreme case just below the sand-box (at the intake of the lined section) the cross-bars had a minimum clearance of 8 or 9 in. While there was practically no smoothness of water surface, generally speaking, the water went onto all curves easily, very often heaped on the inside instead of the outside, as theory requires, and usually went off the curves onto tangents with disturbance. * * * The transporting effect of this velocity was remarkable. A 25-lb. rock fastened on a wire started straight down stream and a 100-lb. rock fastened in the same manner took two men to pull it back and out. An attempt to draw out a pail full of water nearly lost the bucket."

On October 25th, 1909, the writer visited the completed canal at a time when a test was being made of the upper 4 miles. Unfortunately, it was impossible to divert more than about 160 sec-ft. from the river, the water in the lined section flowing 3.2 ft. deep. The characteristics of the larger flow commented on by Mr. Conway on July 4th were noted, however, as existing to a considerable extent. The canal had evidently been constructed with a too rigorous contraction at its entrance at the sand-gates, and at certain points there were noted variations in velocity and depth not readily explainable by alignment or quality of work. It would almost appear that, in long channels of uniform cross-section and slope, such as this, where high velocities obtain, there is a constant tendency of the mass of flowing water to lose and recover the equilibrium of the hydraulic gradient and velocity due to the forces of gravity, and the retarding effect of frictional resistance is overcome or adjusted in part by local and fixed irregularities of flow, and sometimes in traveling surges or waves such as may always be observed in chutes or wasteways where velocities approach that of free falling bodies. In spite of these vagaries of flow, it has been demonstrated that the conduit can be depended on for its full calculated discharge, and possibly even more.

The water introduced was at a temperature little exceeding that of freezing, and the contraction of the masonry lining due to low temperature was noted at a number of joints between the shapes, generally in hair cracks of no appreciable importance, but sometimes in cracks of as much as $\frac{1}{32}$ in., which developed sensible leakage. Many of these cracks had been caulked, and it was evident that reasonably careful treatment would make the canal practically tight. The upper few miles of the conduit tested at this time had been built for more than a year, and had withstood successfully the test of a severe winter. No damage due to heaving by frost was noticed. The principal defects, other than the temperature cracks above noted, were that at a number of points the surface of the concrete was pitted or roughened. Apparently this was due to the breaking away of small patches of plastering which had been applied at defective spots in the shapes when the forms were first removed. This plastering, fortunately, was seldom used, so that serious trouble from this cause need not be anticipated.

In connection with the satisfactory coefficient of flow developed in this conduit, it is interesting to make a comparison with a conduit of almost similar shape on the Umatilla Project, in Oregon. This conduit is 9 ft. in diameter, and is intended to carry 300 sec-ft., or the same quantity as the Tieton Canal. The Umatilla Canal has a reverse curvature of 90°, with curves of 50 ft. radius, which is comparable with the most extreme curvature of the Tieton Canal. The Umatilla Canal was finished in 1907, being built of plain concrete deposited in place in the usual way. The forms used in construction were in 10-ft. panels measured lengthwise of the canal, and the lining was placed in sections of that length, with a complete transverse joint at the end of each section to allow for temperature contraction. The forms were well built, and the masonry was placed with much care and under vigilant inspection so as to insure good workmanship and high hydraulic properties for the channel.

The grades were well kept, and the curves were regular and smooth, although the curves as built actually consisted of a series of 10-ft. tangents, as is usually the case in construction of this type. A very careful test was made during 1909, the surface of the flowing water being measured by a special apparatus which practically eliminated wave effect as a disturbing factor. The quantities were gauged with a current meter.

It was found that, with velocities of 7.2 ft. per sec., the coefficient of discharge in the Chezy formula was about 130, this corresponding with $n = 0.014$ in. Kutter's formula.

Both these canals being new and clean, the difference between their deliveries is worthy of special note. The only explanation offered is that the concrete lining of the Tieton Canal, being cast in smooth and well-oiled metal moulds, has a surface much superior to that of the

Umatilla Canal, which was laid against ordinary dressed lumber forms.

Apparently, little disadvantage, from a hydraulic standpoint, has resulted from the innumerable transverse joints in the Tieton Canal, and the method of construction has been more favorable to hydraulic effectiveness on curves than the standard construction used at Umatilla. On the latter it was noticed that, on curves of the same radius, the disturbance was much greater than on the Tieton Canal. Practically, the only apparent advantage the latter has in its hydraulic surface, other than the smoothness due to the metal forms, is that the curves are worked out in 2-ft. tangents, while on the Umatilla Canal they are in 10-ft. tangents.

The physical difficulties attending the construction of the Tieton Canal were considerable. The cañon was practically inaccessible before work was commenced, except at its lower extremity, and by trails meandering from side to side, sometimes at heights of 800 or 900 ft. above the stream bed and sometimes necessitating dangerous fords.

To make preliminary surveys, the engineers had to establish camps at remote points, where the delivery of the necessities of life was attended with much difficulty.

One of the first steps after completing the surveys was to build a wagon road the entire length of the canal along the bottom of the cañon. This work had been almost completed in the fall of 1906 when a heavy flood practically obliterated all that had been accomplished. Several bridges which had hardly been used were swept away, and the bottom lands were altered, eroded, and heaped up with débris to such an extent that the topography could hardly be recognized. After this flood had subsided, however, operations were immediately resumed, bridges were rebuilt, and the road was completed early in 1907.

The Reclamation Service at once proceeded to develop water-power in order to drive the tunnels, advantage being taken of a steep fall in the river to build a power canal giving at its lower extremity a static head of about 30 ft. The turbine installation developed about 350 h.p., the turbine being belt-connected with a two-stage air compressor and a generator for lighting and power purposes.

All this apparatus was successfully installed and housed toward the end of 1907. Substantial camps were also built at suitable points along the cañon. Another hydro-electric installation was made near the upper end of the canal for operating the mixers and crushers in the various manufacturing yards, and also for hoisting and delivering material and shapes to the canal location. Altogether, about 600 h.p. was developed at two power plants, most of which was transformed, transmitted, and used at distances for construction and lighting purposes.

At the main power station a machine and blacksmith shop was established where all repair work was done and all steel forms, special mechanical devices, and even some rolling stock were manufactured or fitted. Machine drills, lathes, rolls, drill sharpeners and other equipment were set up at this point, the motive power being compressed air. This establishment assumed quite extensive proportions as the work developed, and was the scene of much activity throughout. It should be remembered that operations in so remote a locality necessitated field execution of practically all repair and renewal work, much of which under other conditions would be sent to distant shops.

Time and difficulties of transportation, however, did not permit of much dependence on outside help, and, except in case of breakage or loss of special machinery parts or fittings, practically everything was done in the cañon.

The working season in this country is comparatively short, except for tunnel work. Operations in the open can seldom be carried on before the end of April, especially in connection with masonry work, the snow lingering very late, being sheltered by the depth of the cañon and the forest growth. Roads are usually impassable in the early spring. The building of concrete shapes had also to be stopped by the middle of October, work of this type being particularly susceptible to injury by frost. On one occasion a batch of some 200 shapes manufactured during the end of October and beginning of November, 1907, was injured to such an extent by freezing that most of them had to be destroyed.

Labor frequently proved very difficult to obtain, and more especially during 1907. Wages for common labor varied from $2 to $2.50 per day, tunnel drill men from $3 to $3.75, the working day being 8 hours. It was noted that the effectiveness of labor invariably proved to be in inverse ratio to the rate of wages. The laborers chiefly consisted of so-called "white men," being a cosmopolitan collection of native Americans, Scandinavians, and Germans, with a few English.

The higher classes of labor, such as machinists, sub-foremen, and the like, were practically all native Americans.

It is believed by the writer that construction of this type has not been used elsewhere on any large scale, if at all. It has proved a successful method of building, and may be recommended for adoption elsewhere wherever conditions are such as to warrant such action. It should be remembered, however, that this type of work is particularly exacting on the organization and personnel, probably requiring more careful supervision and control than the standard methods usually adopted.

The engineers in local charge at the commencement of work were Joseph Jacobs, M. Am. Soc. C. E., District Engineer, and E. McCulloh, M. Am. Soc C. E., Resident Engineer, both acting under the direction of D. C. Henny, M. Am. Soc. C. E., Supervising Engineer, and the writer. The organization of the work, however, was mainly built up under the local direction of Mr. C. H. Swigart, then Project Engineer, aided by an able corps of assistants. Much of the success of the work is due to the skill and ingenuity of Mr. Maney, the Superintendent, and Mr. Cronholm, Master Mechanic. The writer was associated with the work until the beginning of 1909, after which it was continued and completed under the direction of Mr. C. H. Swigart as Supervising Engineer and Mr. J. S. Conway, Engineer. All operations were under the general direction of F. H. Newell, M. Am. Soc. C. E., Director, and A. P. Davis, M. Am. Soc. C. E., Chief Engineer, of the Reclamation Service.

Vol. XXXVI. AUGUST, 1910. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE RECONSTRUCTION OF THE PASSENGER TERMINALS AT WASHINGTON, D. C.

By W. F. Strouse, M. Am. Soc. C. E.

To be Presented October 19th, 1910.

Introduction.

Early Legislation.—The question of abolishing grade crossings in the District of Columbia was under discussion for many years, and numerous plans were prepared with this object in view. As early as 1896 it fell to the writer's lot to be assigned the duty of making studies for the reconstruction of the Baltimore and Ohio Railroad Company's yards, buildings, and lines within the District of Columbia. At that time, of 28 streets and avenues crossed by the Baltimore and Ohio Railroad Company's Washington and Metropolitan Branches in the city and suburbs, only one was carried over or under the railroad by a suitable bridge.

None of the many plans and propositions submitted seemed to meet the views of the District and National Authorities until 1900, when a plan presented by the Baltimore and Ohio Railroad Company seemed to be nearer to meeting the requirements than any previous scheme. At about the same time, the Baltimore and Potomac, now the Philadelphia, Baltimore, and Washington Railroad Company, submitted

---

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

plans for the reconstruction of its lines and terminals in the southern section of the city, which likewise met with the approval of the District and National Authorities.

On February 12th, 1901, Congress passed two separate Acts relating to the reconstruction of railroad lines and terminals, and the elimination of grade crossings in the City of Washington. One of these Acts authorized the Baltimore and Ohio Railroad Company to construct a passenger and freight terminal at Delaware Avenue and C Street, N. E., with an elevated approach of masonry arches and retaining walls. The other Act authorized the Philadelphia, Baltimore, and Washington Railroad Company to enlarge its present Sixth Street Station, to elevate and depress its line on Maryland and Virginia Avenues, and to improve its alignment on Virginia Avenue and through Garfield Park.

Historical.--About two months prior, exercises commemorative of the one hundredth anniversary of the removal of the seat of the government to the District of Columbia were held at the White House and Capitol. These exercises were participated in by the Governors of the States as well as by the officials of the General Government and representatives of foreign powers. The key-note of this celebration was the improvement of the District of Columbia in a manner commensurate with the dignity and resources of the American Nation.

During the same period the American Institute of Architects held its session in Washington, and, as a result of a series of papers read and discussed at that time, the Institute appointed a committee on legislation. Consultations between that committee and the Senate Committee resulted in the Senate ordering the preparation and submission of a general plan for the development of the entire park system of the District.

The Senate Committee was authorized to sit during the recess of Congress and to secure the services of such experts as might be necessary to obtain a proper consideration of the subject. The desirability of a comprehensive plan for the development of the District of Columbia, and particularly the City of Washington, had long been felt by all. This had been especially true during recent years when questions relating to the location of public buildings had to be considered, the absence of an approved plan either causing the postponement of decisions or resulting in compromises that marred the beauty and dignity of the National Capital.

On March 19th, 1901, thirty-five days after the passage of the above mentioned Acts, the sub-committee of the Senate Committee met the representatives of the American Institute of Architects and agreed to the proposition of the latter that Mr. Daniel H. Burnham, of Chicago, Ill., and Mr. Frederick Law Olmsted, of Brookline, Mass., be engaged as experts, with authority to add to their number. The task was accepted by these gentlemen, who invited Mr. Charles F. McKim and Mr. Augustus St. Gaudens, of New York City, to act with them in the preparation of plans.

As Director of Works of the World's Columbian Exposition, held in Chicago in 1893, Mr. Burnham was instrumental in securing the adoption of a scheme of construction which placed that exposition in the very front rank of international expositions, and, by the display of rare executive ability, brought about and maintained that effective co-operation of architects and artists which gave to American art a new direction and a tremendous impetus.

Mr. Olmsted's name is synonymous with what is best in modern landscape architecture. He is the consulting landscape architect, not only of the vast system of parks and boulevards of Boston and suburbs, but of many other cities. To his inherited tastes is added the highest training, both practical and theoretical.

As architect of the Boston Public Library, the Rhode Island Capitol, the fence and new buildings of Harvard, and other structures of monumental character, Mr. McKim, now deceased, was recognized as without a superior among American architects, on account of the simplicity, directness, and scholarly qualities of his work.

In Mr. St. Gaudens, whose recent death removed a man who unquestionably stood first among American sculptors, the commission included one whose criticisms had the authority of law among architects and artists.

Immediately following the appointment of this commission, a detailed examination of the topographical features of the District of Columbia was made, and preliminary plans were prepared. The commission was forced to the conclusion that a proper treatment of the park system could not be had without the exclusion of the Philadelphia, Baltimore, and Washington Railroad Station from public grounds, and the Baltimore and Ohio Railroad from a site one square distant from the Capitol grounds.

The right of occupation of the Mall by the Philadelphia, Baltimore, and Washington Railroad dates back to March 23d, 1871, at which time the local government of the District of Columbia granted to the Baltimore and Potomac Railroad Company the necessary land. This action was confirmed by Congress on May 21st, 1872. At the time this grant was made the development of this section of the city was such that the conditions were improved by the change. Inasmuch, however, as the grant was confirmed by Congress, the Railroad Company held the right to use the property by title good both in law and equity. In addition to this right Congress had just passed an Act permitting it to enlarge its present facilities, in consideration of the surrender of certain street trackage and the elevation of its tracks within the City of Washington.

Some time prior to the appointment of the above mentioned committee, Mr. Burnham, chairman of the commission, had prepared preliminary plans for the reconstruction of the Philadelphia, Baltimore, and Washington Railroad Station, as above provided. After consultation with the District sub-committee, he recommended that the Philadelphia, Baltimore, and Washington Railroad Company build its station on the south side of the Mall so as to remove its tracks and buildings from public grounds. The architectural advantages of the proposed site were set forth with such vigor as to command serious consideration. This resulted in delaying the work on the terminals covered by the two Acts.

The commission, in order to make a closer study of the practice of landscape architecture as applied to parks and public buildings, made a trip to Europe, visiting Rome, Venice, Vienna, Paris, Budapest, and London, and their suburbs. While on this trip the commission met the President of the Pennsylvania Railroad Company, who agreed to consider the question, not of moving the station to the south side of the Mall, but of withdrawing entirely from that region and uniting with the Baltimore and Ohio Railroad Company in the construction of a union station on the site established by previous legislation for that road, provided that suitable legislation could be obtained to compensate his company for the expense such a change would involve, and provided, also, that the approaches to the new station be made worthy of the building the railroad companies proposed to erect.

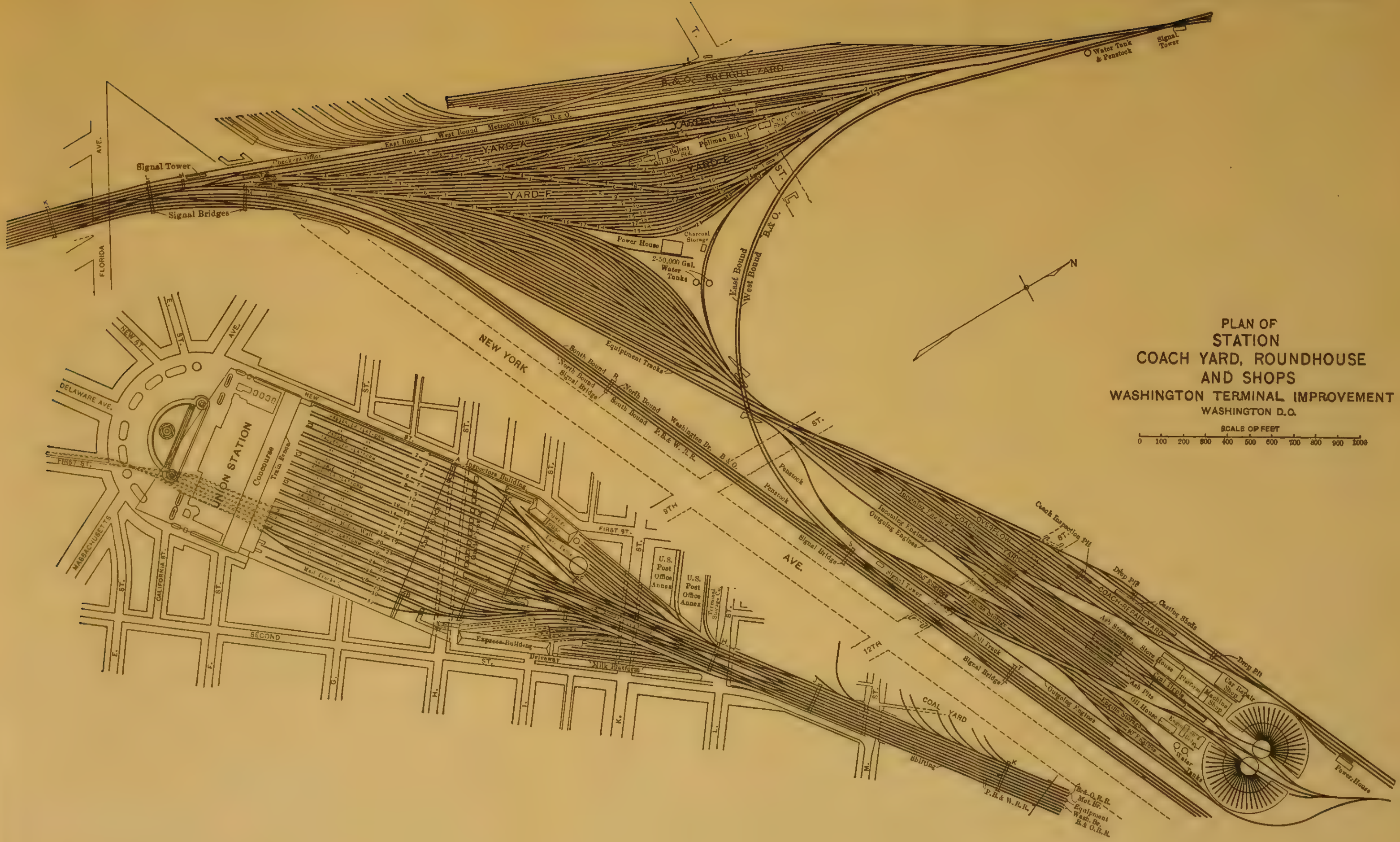
Selection of Site.—To select a site and prepare a plan which would

PLATE CX.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
STROUSE ON
THE WASHINGTON TERMINAL STATION.

PLAN OF STATION COACH YARD, ROUNDHOUSE AND SHOPS

WASHINGTON TERMINAL IMPROVEMENT

WASHINGTON D.C.



provide the facilities required for conducting the business of all railroad companies entering Washington involved considerable thought and labor on the part of the officers of the railroad companies and the architects. The site selected by the Baltimore and Ohio Railroad for a passenger terminal at Delaware Avenue and C Street received due consideration, and contained many desirable features. It was felt, however, that the erection of a train-shed extending across Massachusetts Avenue, one of the main thoroughfares of the city, would destroy the vista, and the construction of a large station at this point would place a busy commercial center too near the Capitol grounds.

Other locations for the station were suggested, especially a site on the north side of Staunton Square. This location simplified the northern approach, but required a longer and more expensive approach from the south. In the consideration of the various sites, the commission kept in mind the development of the park system. This seemed to require the complete removal of railroad facilities from the Mall and the abandonment of the Baltimore and Ohio site at C Street. After due consideration the commission suggested the intersection of Massachusetts and Delaware Avenues as a proper site. This placed the station on the line of the proposed Baltimore and Ohio development, but about three blocks farther from the Capitol grounds.

This location was accepted by the railroad companies as the site for a union station which would permit of a treatment in harmony with the general park system, and at the same time allow a proper development of the Mall. Owing to the relative location of the two railroad systems and the distance separating them, it was difficult to secure a proper connecting link between them without awakening unfavorable sentiment. With this location, however, there seemed to be only one possible connection between the existing lines in the northern and southern sections of the city and the union station, namely, by way of First Street, E., between the Library of Congress and the Capitol and Delaware Avenue, a suggestion made some years ago but against which there was considerable feeling, both as to the construction and the operation of a tunnel between two prominent public buildings.

Additional Legislation.—Plans were then prepared and a bill was introduced into Congress, at the session of 1902-03, providing for the construction of a union station of monumental design on the north side of Massachusetts Avenue, with the necessary north and south approaches. This bill, supplementary to some extent to the Acts of 1901, but covering such changes as were necessary to meet the requirements of the companies concerned, was passed on February 28th, 1903.

In general, it adopted for the north approach the plans of the Baltimore and Ohio Railroad under its Act of 1901. It provided for the abandonment of the Sixth Street Station and the removal of the tracks of the Philadelphia, Baltimore, and Washington Railroad from the Mall; the construction of the Baltimore and Ohio Railroad freight terminal at New York and Florida Avenues, N. E., about one mile north of its original location; its coal yard on Square 711 adjoining Delaware Avenue between M and N Streets, and the necessary shops and yards east of Eckington. It also provided for the construction of a new connection with the Philadelphia, Baltimore, and Washington Railroad at Magruder, known as the Magruder Branch.

The problem of bringing together by legislation two large competing railroad lines into a union station, particularly in a section of Washington so far developed and surrounded by so much sentiment, was not easily accomplished. The people had cherished the hope for many years that a union station might be constructed, but the suggestion received no encouragement from the railroad companies.

In line with the proposed treatment of the park system, the front of the station building was located 150 ft. north of the intersection of Massachusetts and Delaware Avenues. To make the structure more imposing, the main floor elevation was fixed at 58 ft. above mean tide, or about 35 ft. above the original ground level. On masonry foundations, carried to this elevation, has been placed a building, the highest point of which is 122 ft. 10 in. above the floor level.

The ground occupied by the west end of the building was formerly used by the Baltimore and Ohio Railroad as a coal yard; the east end is on ground originally occupied by private residences; and the center occupies Delaware Avenue, formerly the roadbed of the Baltimore and Ohio Railroad.

North Approach.—As previously stated, the north approach for both companies occupies the route selected by the Baltimore and Ohio Railroad and covered by its Act of 1901, except that there has been a marked increase in the number of tracks. The roundhouses and shops, which by former legislation were to be located in Eckington,

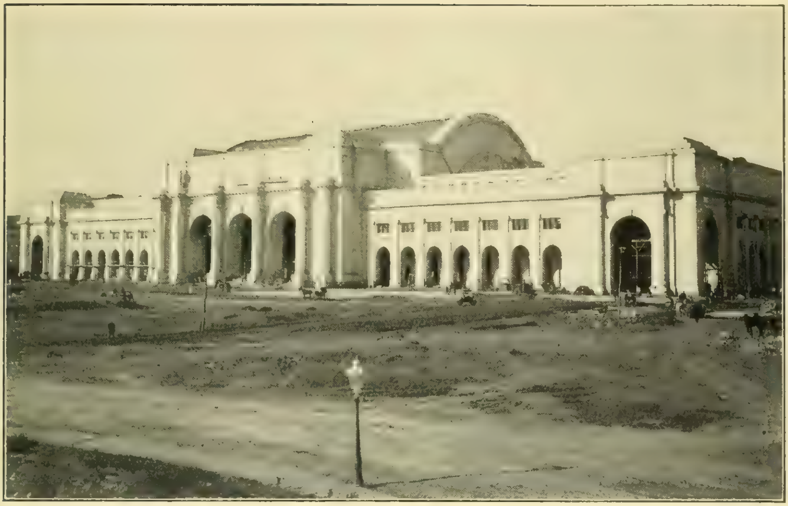


FIG. 1.—WASHINGTON TERMINAL STATION: FRONT ELEVATION.

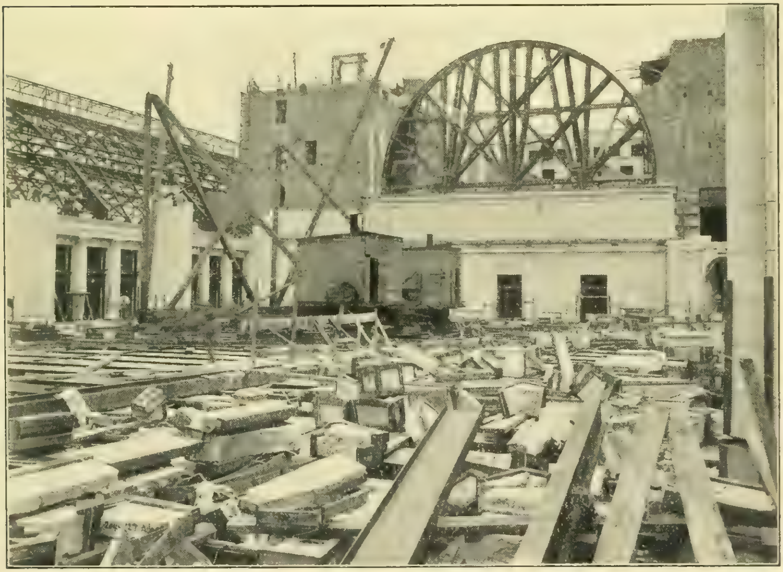


FIG. 2.—WASHINGTON TERMINAL STATION: INTERIOR OF MAIN WAITING-ROOM DURING CONSTRUCTION.

have been erected, about ¾ mile farther east, on what was formerly known as the Ivy City race-track property. At this point facilities have been provided for caring for the rolling stock of all companies operating trains into the union station.

Roughly speaking, the north approach occupies Delaware Avenue from Massachusetts Avenue to Florida Avenue. At this point the tracks of the Washington Branch of the Baltimore and Ohio Railroad and the Philadelphia, Baltimore, and Washington Railroad curve to the east to a line parallel to New York Avenue and 100 ft. northwestward therefrom. At Montana Avenue these lines diverge, the Washington Branch connecting with the old line at Langdon, and the Philadelphia, Baltimore, and Washington continuing eastward and joining the old line at Magruder. From Florida Avenue the Metropolitan Branch of the Baltimore and Ohio Railroad continues northward to a connection with the old line near University Station.

In making these changes the old lines of both the Washington and Metropolitan Branches of the Baltimore and Ohio Railroad were abandoned for a distance of about 3 miles each. The roadbed of the Metropolitan Branch for about half the distance, however, is used in the freight yard development. The Philadelphia, Baltimore, and Washington Railroad Company retains all its old lines except from Maryland Avenue to the old Sixth Street Station, and there were some slight changes in the yard development.

South Approach.—The south approach is by way of a double-track tunnel under First Street, E., from the station at Massachusetts Avenue to B Street, S. E., from which point the line curves to the west through private property to New Jersey Avenue and D Street, S. E. From this point to a connection with the Philadelphia, Baltimore, and Washington Railroad tracks on Virginia Avenue near Second Street, S. W., the line is by open cut and viaduct.

From Second Street and Virginia Avenue west to a point near Seventh Street an elevated structure wide enough for four tracks was built in the bed of Virginia Avenue. At Seventh Street the line curves into Maryland Avenue which has been converted into an open cut wide enough for four tracks. At Fourteenth Street the line curves to the south to a connection with the new steel bridge across the Potomac River immediately west of the site of the old Long Bridge. The double-track connection to the south is used only as a passenger line, the handling of freight being prohibited by the Act of Congress except in case of accident, and then only for a limited time.

East of Virginia Avenue and Second Street, W., all tracks of the Philadelphia, Baltimore, and Washington Railroad are used exclusively for handling freight. All passenger traffic is now handled over the Magruder Branch, the north approach to the station, and through the tunnel to the south.

STATION.

In the design of the station much thought was given to the architectural features. Since Greece and Rome have furnished architectural inspiration for so many of the public buildings of Washington, a freely interpreted classic may be considered as the recognized architecture of these structures, and, as the new station was to be the one gateway of the Capital, it seemed fitting that the architectural motives should be drawn from the triumphal arches of Rome.

Some of the elements entering into the design of the terminal were unique. In most cities the probable future growth and nature of the traffic plays an important part in the planning of a passenger terminal. Washington has very little suburban traffic, and, as it will never become a commercial center, the question of providing for future growth was of minor importance. The main problem was how to care for and provide against abnormal conditions, which arise at least once every four years. The handling of inauguration crowds has always been a heavy expense to the railroads because they have had to provide such elaborate temporary facilities. On the other hand, to provide adequate permanent facilities meant a large expenditure, with the attendant heavy carrying charges. On account of the dilapitated condition of the passenger facilities owned by both companies, and the urgent need of larger and better terminals, a union terminal seemed to show advantages over the separate stations provided for in the Acts of 1901.

The layout embraces every feature and facility involved in the construction of a first-class railroad, including a depot building planned and constructed after the most modern lines, and containing every feature for the convenience, comfort, and pleasure of the traveling public; the most complete and up-to-date facilities for conducting the business of a large railroad station; a main power-plant for furnishing power of every kind required for the successful operation of the station and yards; a large and completely equipped express terminal for car-

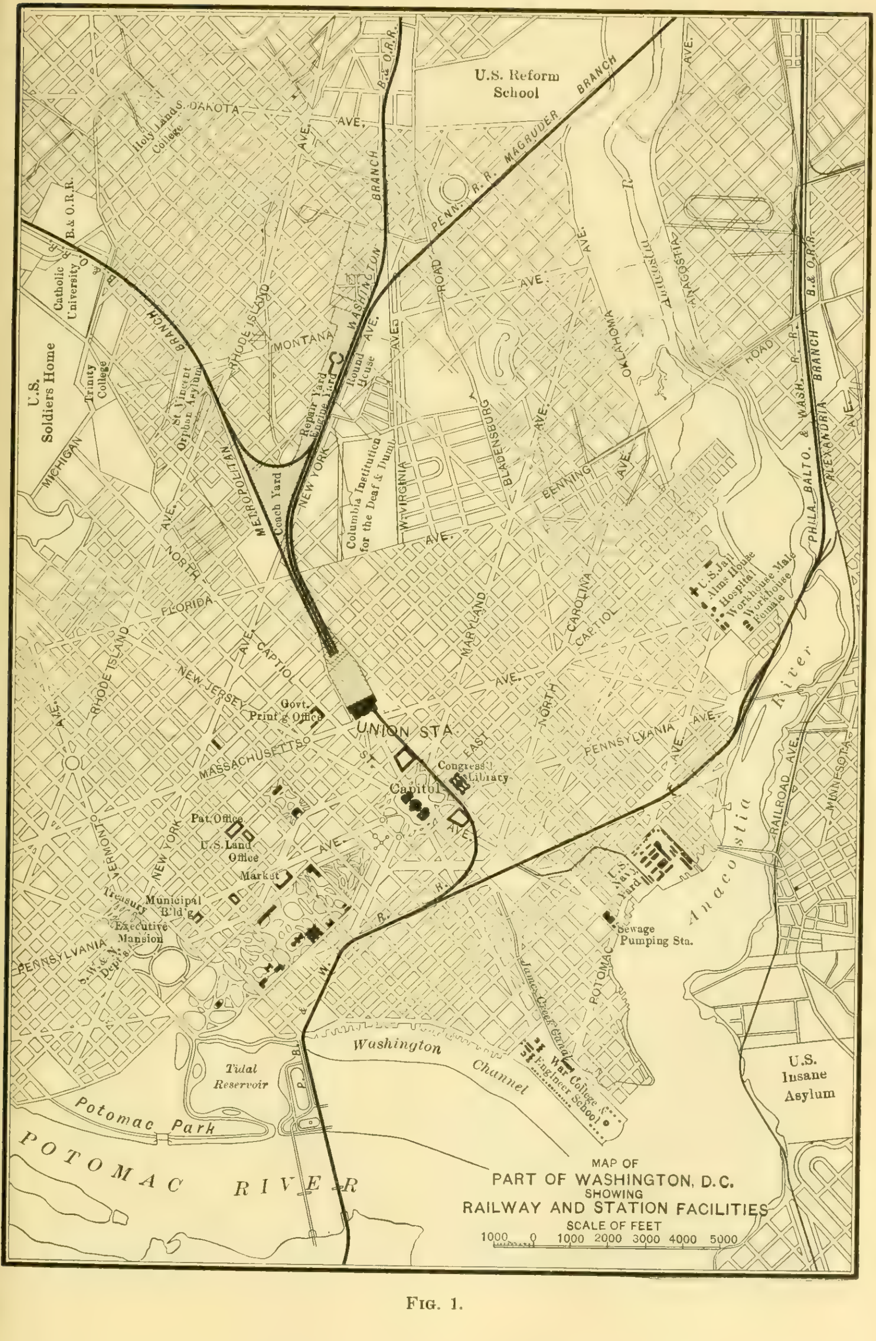

MAP OF
PART OF WASHINGTON, D.C.
SHOWING
RAILWAY AND STATION FACILITIES
SCALE OF FEET
1000 0 1000 2000 3000 4000 5000
U.S. Reform School
Holy Land College
S. DAKOTA AVE.
B.& O.R.R.
WASHINGTON BRANCH
PENN. R.R. MAGRUDER BRANCH
Catholic University
U.S. Soldiers Home
Trinity College
St. Vincent Orphan Asylum
RHODE ISLAND AVE.
MONTANA AVE.
Round House
Repair Yard
Engine Yard
Coach Yard
METROPOLITAN BRANCH
NEW YORK AVE.
Columbia Institution for the Deaf & Dumb
W. VIRGINIA AVE.
BLADENSBURG ROAD
OKLAHOMA AVE.
ANACOSTIA AVE.
Anacostia
BENNING AVE.
MICHIGAN
NORTH
FLORIDA AVE.
CAPTIOL
NEW JERSEY
Govt. Print'g Office
UNION STA.
MASSACHUSETTS
Congress'l Library
Capitol
EAST
MARYLAND AVE.
NORTH CAROLINA
CAPTIOL
PENNSYLVANIA AVE.
U.S. Jail
Alms House
Hospital
Workhouse Male
Workhouse Female
River
PHILA. BALTO. & WASH. R.R.
ALEXANDRIA BRANCH
B.& O.R.R.
MINNESOTA AVE.
RAILROAD AVE.
Pat. Office
U.S. Land Office
Market
Municipal B'ld'g
Treasury
Executive Mansion
VERMONT
NEW YORK
PENNSYLVANIA
B.& P. Depot
Sewage Pumping Sta.
U.S. Navy Yard
Anacostia River
James Creek Canal
POTOMAC
War College & Engineer School
Washington Channel
Tidal Reservoir
Potomac Park
POTOMAC RIVER
U.S. Insane Asylum
P. W. & B. R.R.

FIG. 1.

ing for the express business handled by the Adams, Southern, and United States Express Companies; a modern commodious roundhouse and shop layout for caring for repairs to equipment; the most complete interlocking layout and intercommunication system ever constructed; one of the most complete passenger equipment yards ever built, and a track system covering yards and main tracks within the passenger terminal zone aggregating about 60 miles of single track.

The head-house is 626 ft. 10 in. long and 210 ft. 9 in. wide, exclusive of the space taken up by the columns in front of the central pavilion or main portico. The front and ends are made up of groups of semicircular arches characteristic of Roman architecture. The main portico or central pavilion consists of three arches, each 29 ft. 6 in. wide and 48 ft. 9 in. high. Flanking it on either side are seven arches, each 12 ft. 4 in. wide and 24 ft. 8 in. high, while the end pavilions are composed of arches 22 ft. wide and 38 ft. 6 in. high.

The west end is made up of five arches 19 ft. 2 in. wide and 37 ft. 7 in. high, and one arch 12 ft. 4 in. wide and 24 ft. 8 in. high. The former are used as exits for carriages from the carriage porch, the latter to carry out the open portico treatment across the front. At the east end there are five arches, 12 ft. 6 in. wide and 24 ft. 8 in. high, leading to the open portico, two windows with arch treatment, and one arch, 22 ft. wide and 38 ft. 6 in. high, leading to a carriage pavilion.

The east pavilion leads to a suite of rooms for the use of the President and the guests of the Nation, the west pavilion to the carriage porch at the west end of the ticket lobby. The central and end pavilions are connected by a portico or loggia from 14 ft. 6 in. to 16 ft. 6 in. wide, the portico and pavilions forming a continuous covered porch the entire length of the structure, and affording protection from the elements. The east and west wings of the building are 69 ft. 7½ in. above the floor level, and the domes over the carriage entrances are 78 ft. 3½ in. above the same point. The dome over the main waiting-room is 122 ft. 10 in. high.

The concourse in the rear of the head-house is 760 ft. long and 130 ft. wide, exceeding by nearly 9 ft. the length of the Capitol. It is covered by a segmental arched ceiling 45 ft. high in the center and 22 ft. at the springing line above the main floor. About 40% of the ceiling area is of glass, the remainder is artistically coffered ornamental plaster. The concourse is divided by the usual train fence into two

PLATE CXII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
STROUSE ON
THE WASHINGTON TERMINAL STATION.

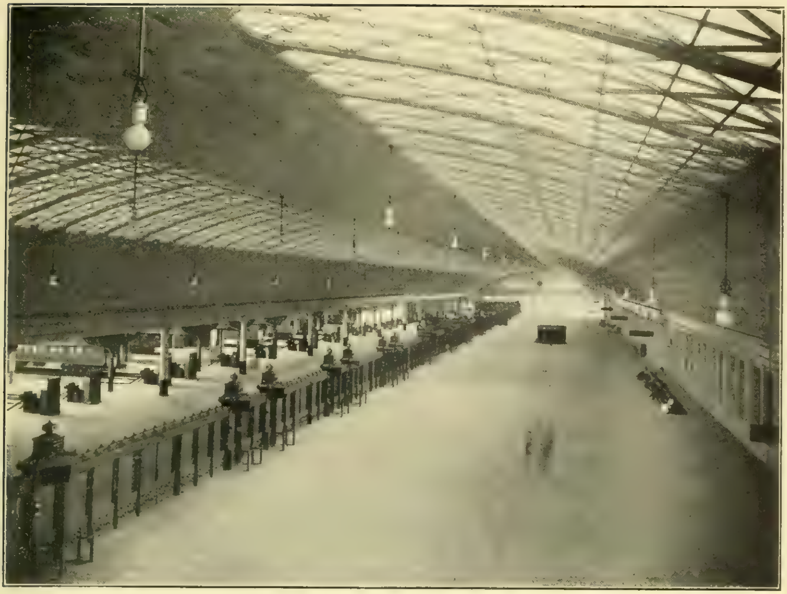


FIG. 1.—WASHINGTON TERMINAL STATION: CONCOURSE.

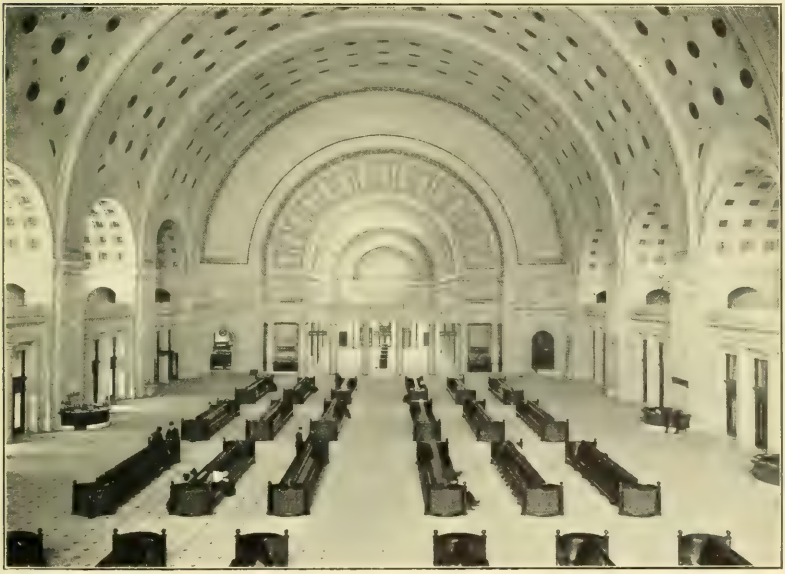


FIG. 2.—WASHINGTON TERMINAL STATION: GENERAL WAITING-ROOM.

sections, that on the station side being 83 ft. wide, and that on the track side, 47 ft.

The general waiting-room has a clear width of 120 ft., is 219 ft. long, exclusive of the colonnades, and is covered by a Roman barrel-vaulted ceiling, its highest point, exclusive of coffers, being 96 ft. above the floor level. The decorations are sunken panels patterned after the baths of Diocletian. It is lighted by a semicircular window 72½ ft. in diameter at the east end, by three semicircular windows in the south side and five on the north side, each 27½ ft. in diameter, and by the glass roof over the ticket lobby at the west end. Imperial Rome at her greatest did not possess a hall of such proportions.

The fronts of the large piers along the north side of the room are occupied by two granite drinking fountains and two telegraph booths, one for the Western Union and the other for the Postal Telegraph Company. There are similar drinking fountains in front of the corresponding piers in the south side, and the spaces in front of the two remaining piers are occupied by a news-stand and a flower-booth. In the south side of this room there are two semicircular alcoves. The one near the west end of the room contains a public telephone station with an exchange and fourteen booths. The alcove near the east end contains a drug store with the usual counters, cases, and a soda fountain. For the comfort of patrons, the central portion of the waiting-room is fitted with large comfortable settees, arranged to provide ample space for circulation between them at all times.

The dining-room at the east end of this hall is 80 ft. wide and 100 ft. long, and the ceiling is 29 ft. 6 in. high. On the north and south sides there are alcoves which add greatly to the coziness of the room. On account of its location, no light could be obtained from the sides except through clerestory windows. To overcome this difficulty, a saw-tooth roof was provided, the north inclines of which are of glass. The ceiling is artistically paneled, and nearly the entire area is covered with glass.

The lunchroom is 32 ft. 6 in. wide, 120 ft. long and has a ceiling 28 ft. 8 in. high. It is on the north side of the dining-room, overlooking the concourse. The large windows in the north wall and the clerestory windows furnish ample natural light. Like the dining-room, the lunchroom has alcoves on the north side.

The women's waiting-room is 42 ft. wide and 75 ft. long, with a ceiling 29 ft. 2 in. high. It is south of the dining-room, and is a large cheerful apartment with windows opening on the portico and overlooking the plaza.

The smoking-room is 37 ft. wide and 54 ft. long, with a ceiling 28 ft. 6 in. high, and is at the west end of the general waiting-room, fronting on the portico. Adjacent to the smoking-room is found the barber shop and shoe-shining establishment.

The ticket lobby, 50 ft. wide and 100 ft. long, covered by a semicircular glass roof, is at the west end of the general waiting-room, immediately north of the smoking-room, the ceiling being about 60 ft. above the floor.

The baggage checking-room is on the north side of the ticket lobby; it is 49 ft. wide and about 124 ft. long, with a ceiling 20 ft. high. On the south side are the ticket-offices, consisting of a Pullman ticket-office and seven railroad ticket-offices, at each of which tickets over all railroads entering Washington can be purchased.

The bureau of information and the stop-over ticket-offices are under the colonnade at the entrance to the ticket lobby, and there is a parcel-room at the northwest corner of the main waiting-room, having windows opening into the main waiting-room and on the concourse.

The state apartment, at the extreme east end of the station, consists of a reception-room 30 ft. wide and 70 ft. long with a ceiling 28 ft. 8 in. above the floor, and with north and south vestibules and private retiring-rooms on either side of the main entrance.

There are large and commodious toilet-rooms adjoining the women's waiting-room at the east end of the station, and adjoining the barber shop at the west end. In both cases there are a number of pay toilets, fitted out in the best manner with lavatories, where patrons, by paying a small fee, may obtain a towel, soap, comb and brush, and hot and cold water.

Statuary and Inscriptions.—The complete architectural treatment of the front elevation of the station includes six stone statues and four eagles, the former over the central pavilion, the latter over the carriage entrances at the east and west ends. This statuary is placed in front of the great friezes over the main entrance arches and over the carriage archways, and, with the inscriptions in the panels between, have been made a special architectural feature.

Before the adoption of the scheme now being executed, a number of suggestions for the subjects of the statues and inscriptions were

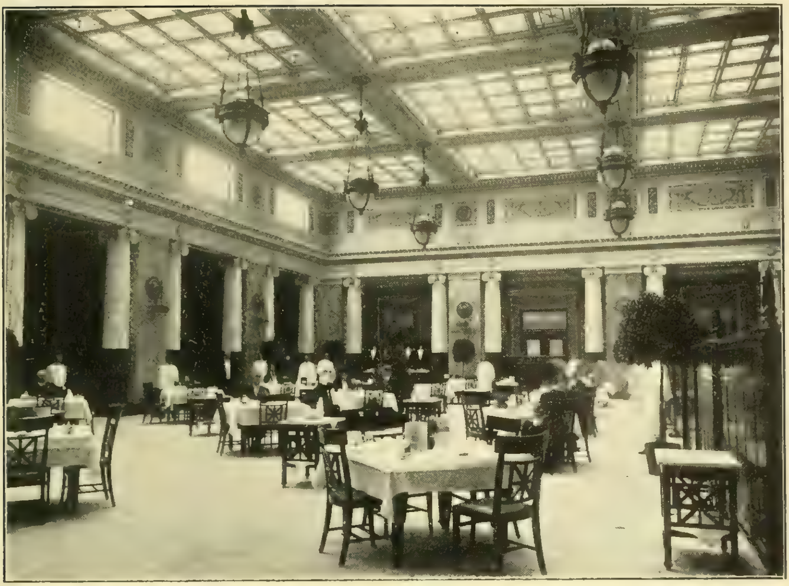


FIG. 1.—WASHINGTON TERMINAL STATION: DINING ROOM.

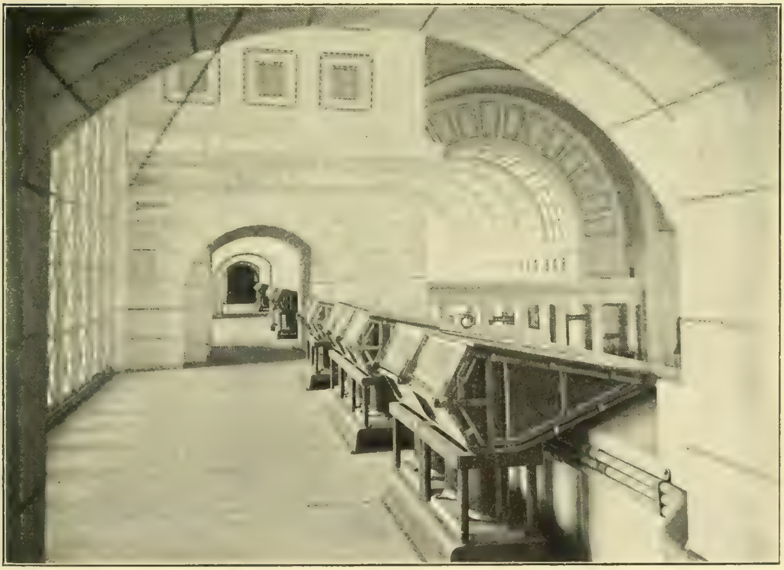


FIG. 2.—WASHINGTON TERMINAL STATION: BALCONY IN MAIN WAITING-ROOM, SHOWING LIGHTING EQUIPMENT.

secured, ranging from the explorers and discoverers of this country to the various inventors who have had most to do with the development of transportation. The general architectural treatment of the building, however, was such as to preclude the usual portrait statues. To make them take their place as part of the architecture required that they be limited to allegorical draped figures, forming simple massive silhouettes against the vast frieze.

In the development of the complete scheme, embracing the subjects for the statuary, with appropriate inscriptions in the intervening panels, Ex-President Charles W. Eliot, of Harvard University, was consulted. The result is an appropriate and adequate treatment of the decorative frieze over the doorway of the vestibule to the Capital of the Nation.

The general decorative features of the main entrance to the building consist of six massive stone columns, two on each side and one in front of each pier supporting the main arches. Upon pedestals on the tops of these columns the granite statues, about 18 ft. high, will be placed, those on the west side of the entrance representing Prometheus and Thales, typifying Fire and Electricity, those on the east side Ceres and Archimedes, typifying Agriculture and Mechanics, while Freedom and Imagination are depicted by the central figures. Those on the west side represent two of the great forces connected with the operation of railroads, those on the east owe much of their development and wealth to the railroads. The central figures typify the atmosphere of freedom in which the inventive imagination has been able to accomplish such great results.

The columns flanking the carriage entrances are surmounted by stone eagles about 8 ft. high. The following inscriptions have been cut in the three granite panels over the main entrance:

WEST (PROMETHEUS AND THALES).

FIRE—GREATEST OF DISCOVERIES
ENABLING MAN TO LIVE IN VARIOUS CLIMATES
USE MANY FOODS—AND COMPEL
THE FORCES OF NATURE TO DO HIS WORK

ELECTRICITY—CARRIER OF LIGHT AND POWER
DEVOURER OF TIME AND SPACE—BEARER
OF HUMAN SPEECH OVER LAND AND SEA
GREAT SERVANT OF MAN—ITSELF UNKNOWN

THOU HAST PUT ALL THINGS UNDER HIS FEET

Central (Freedom and Imagination).

SWEETENER OF HUT AND OF HOME
BRINGER OF LIFE OUT OF NOUGHT
FREEDOM O FAIREST OF ALL
THE DAUGHTERS OF TIME AND THOUGHT

MAN'S IMAGINATION HAS CONCEIVED ALL
NUMBERS AND LETTERS—ALL TOOLS VESSELS
AND SHELTERS—EVERY ART AND TRADE—ALL
PHILOSOPHY AND POETRY AND ALL POLITIES

THE TRUTH SHALL MAKE YOU FREE

East (Ceres and Archimedes).

THE FARM—BEST HOME OF THE FAMILY—MAIN
SOURCE OF NATIONAL WEALTH—FOUNDATION OF
CIVILIZED SOCIETY—THE NATURAL PROVIDENCE

THE OLD MECHANIC ARTS—CONTROLLING NEW
FORCES—BUILD NEW HIGHWAYS FOR GOODS
AND MEN—OVERRIDE THE OCEAN—AND MAKE
THE VERY ETHER CARRY HUMAN THOUGHT

THE DESERT SHALL REJOICE AND BLOSSOM
AS THE ROSE

In the panels over the entrances to the carriage porch and state apartment the following inscriptions have been cut:

Carriage Porch (South Elevation).

HE THAT WOULD BRING HOME THE
WEALTH OF THE INDIES MUST CARRY
THE WEALTH OF THE INDIES WITH HIM
SO IT IS IN TRAVELLING—A MAN
MUST CARRY KNOWLEDGE WITH HIM
IF HE WOULD BRING HOME KNOWLEDGE

State Apartment (South Elevation).

LET ALL THE ENDS THOU AIMST AT BE
THY COUNTRY'S—THY GOD'S AND TRUTH'S

BE NOBLE—AND THE NOBLENESS THAT
LIES IN OTHER MEN—SLEEPING BUT
NEVER DEAD—WILL RISE IN MAJESTY
TO MEET THINE OWN

STATE APARTMENT (EAST ELEVATION).

WELCOME THE COMING
SPEED THE PARTING GUEST

VIRTUE ALONE IS SWEET SOCIETY
IT KEEPS THE KEY TO ALL
HEROIC HEARTS AND OPENS YOU
A WELCOME IN THEM ALL

The scope of the idea seems to harmonize with the magnificent scale and the monumental character of the building, as well as with the great rôle it is to play in the life of the Capital.

Plaza.—To provide a proper setting for the station, a plaza 940 ft. long and 540 ft. wide, with appropriate decorations, was constructed in front of it. As previously stated, the average ground level in this vicinity was such as to require a fill of about 35 ft. around the station and over a large portion of the space occupied by the plaza. This naturally involved radical changes in the elevations of the streets contiguous to the station and plaza. With the exception of the new streets along the east and west ends of the station, however, the grades of new and existing streets were changed so as to provide easy approaches to the station.

As the original ground had a slight fall toward the southwest, with a corresponding rise toward the east, the changes toward the latter direction were naturally much shorter than those toward the west. In addition to the existing streets, four new ones were created, and several of the existing ones were changed so as to conform better to the general plaza scheme.

The decorations immediately in front of and along the sides of the east and west carriage entrances to the station consist of handsome stone balustrades, upon which at proper intervals there are ornamental iron lamp-posts. Flanking the approaches to the carriage porch and state apartment from the south, the end posts of the balustrades support ornamental iron rostral columns about 30 ft. in height above the pavement level. The tops of these columns terminate in spheres surmounted by eagles.

Each rostral column contains two inverted, series, arc lamps enclosed in 20-in. globes, about 16 ft. above the street level. All other lamp-posts on these balustrades are about 16 ft. above the street level, each containing one inverted, series, arc lamp enclosed in a globe 26 in. in diameter.

Two other groups of balustrades surround handsome stone fountains opposite the centers of the east and west wings of the station. There is a line of ornamental iron lamp-posts, 16 ft. high, supported on granite pedestals, between the ends of the balustrades around the fountains, effecting a uniform treatment across the entire front of the station. There are also lines of ornamental iron lamp-posts, 11 ft. high, arranged for use with incandescent lamps, around the outer edges of the central island and plaza, and there is a line of arc lamp-posts, 29 ft. 3 in. above the plaza grade, on islands on a circle inside the street-car tracks. Two series arc lamps are suspended from a cross-arm near the top of each of these lamp-posts, the centers of the lamps being 24 ft. above the street level.

All stone used in the decoration of the plaza, except that in the bowls of the fountains, is white granite, from Bethel, Vt., from the same quarry as that used in the station building. The fountain bowls are of green granite, from Rockport, Me. The upper bowls are 13 ft. in diameter, and cut from a single piece of stone; the lower bowls are 22 ft. 6 in. in diameter, the rims being made from eight separate pieces of granite. The bottoms of these bowls are of reinforced concrete, and are lined with sheet lead.

Immediately in front of the central pavilion, there are foundations for three ornamental iron flagstaffs, 110 ft. in height, the ornamental base and decorative portions of which are to be executed in bronze. For still further decoration, Congress has appropriated $100 000 to be expended on a Columbus Memorial to be placed at the intersection of Massachusetts and Delaware Avenues, toward the south side of the plaza.

The stone balustrades immediately in front of and along the sides of the east and west carriage entrances to the station were furnished and erected by the E. B. Ellis Granite Company, of Northfield, Vt. The fountains and the balustrades around them were furnished and erected by the Woodbury Granite Company, of Hardwick, Vt. All ornamental ironwork on the balustrades, etc., in connection with the station and plaza, was furnished and erected by the Chicago Ornamental Iron Company, of Chicago, Ill.

The space between the curb line in front of the station and the north side of the central island, including that occupied by street-car tracks, was paved with wood blocks by the United States Wood Preserving Company, of New York. These blocks are $3\frac{1}{2}$ in. deep, and were laid and grouted with hydrolene on a concrete base provided by the Terminal Company. When the plaza fill has completely settled, the remaining roadway space will be paved with sheet asphalt, and the space used exclusively by pedestrians will be provided with cement pavements.

To create the plaza and fill, the streets leading to it required about 750 000 cu. yd. of material, and at least 250 000 cu. yd. were deposited on vacant property in the zone of the Terminal Improvements, bringing it to the elevation of the adjoining streets.

The construction of the terminal station was not entrusted to one general contractor, but separate contracts were made for each branch. This plan was adopted in the interest of economy in construction and because of the magnitude of the undertaking. Propositions were invited from the leading contractors of the country covering the different classes of work, and from the bids thus received the selections were made. In addition to the economical considerations, the company in this way hoped to prevent trouble with unreliable sub-contractors such as are sometimes selected by general contractors. With one or two exceptions, the selections were very satisfactory, and, but for these, this plan would have worked out well. The principal contracts for the building were let in October, 1903.

Foundations and Granite Work.—The contract for foundations and masonry, cut stone, and brickwork was let to the Thompson-Starrett Company, of New York. All masonry below the finished street and plaza grades is of concrete; above these points it is of stone and brickwork. The exterior walls of the head-house and the interior walls of the main waiting-room and ticket lobby are of white granite, from quarries near Bethel, Vt., the only place at present known where granite of this color can be obtained in quantity. The interior partitions and the backing of all exterior walls are of local red brick.

The interior walls of the concourse are finished in white enamel brick with enamel terra cotta trimmings. The walls of the light-wells and the exterior of the arches in the ends of the main waiting-room are faced with white enamel and buff pressed brick. Hard-burned sewer brick, laid in Portland cement mortar, were used in all arches having spans of more than 16 ft. and in piers for carrying walls and arches. The north wall of the head-house above the junction of the concourse roof is of hard-burned red brick.

The concrete used in the foundations and elsewhere was composed of 1 part Portland cement, 2 parts bank sand, and 4 parts crushed limestone. The mortar used in setting the granite was composed of 1 part non-staining cement, 6 parts slaked lime, and 6 parts white sand. For pointing, the same materials were used, in the proportion of 1 part cement, 1 part lime putty, and 2 parts white sand.

The mortar used in common brickwork was composed of 1 part Portland cement and 3 parts sand tempered with lime paste. For the terra cotta and enamel brickwork the mortar was made of 1 part non-staining cement, 1 part lime putty and 2 parts white sand. The dressed granite ranged from 4- to 8-cut work.

Steelwork.—The contract for the structural steelwork in the station and concourse was let to the American Bridge Company, of New York. As it was essential that the setting of the steelwork and masonry should go on simultaneously, the erection of the steelwork was sub-let to the Thompson-Starrett Company, the masonry contractor. All the interior consists of structural steel and fire-proofing, including particularly the floor and partition construction, and, except where beams and girders are supported on exterior walls, is supported on steel columns carried on concrete foundations.

The steelwork of special note, however, is the roof of the concourse and main waiting-room. The spans of 130 ft. are common to both roofs. The lower chords of the concourse trusses are segmental arches having a rise of 23 ft. The depth of truss is 16 ft. The lower chords of the main waiting-room trusses are semicircular. The trusses are about 20 ft. deep. The trusses in these roofs were erected with a traveler about 40 ft. square and more than 100 ft. high, with booms on the corner posts for raising the load and a small stiff leg on top for guiding it.

Roofing and Sheet-Metal Work.—The roofing, sheet-metal, and skylight work was furnished and erected by J. C. McFarland and Company, of Chicago, Ill. The roofs of the main waiting-room and carriage porch are of reinforced concrete tiles, the roof of the concourse is of reinforced concrete tiles and skylight construction, that

PLATE CXIV.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
STROUSE ON
THE WASHINGTON TERMINAL STATION.

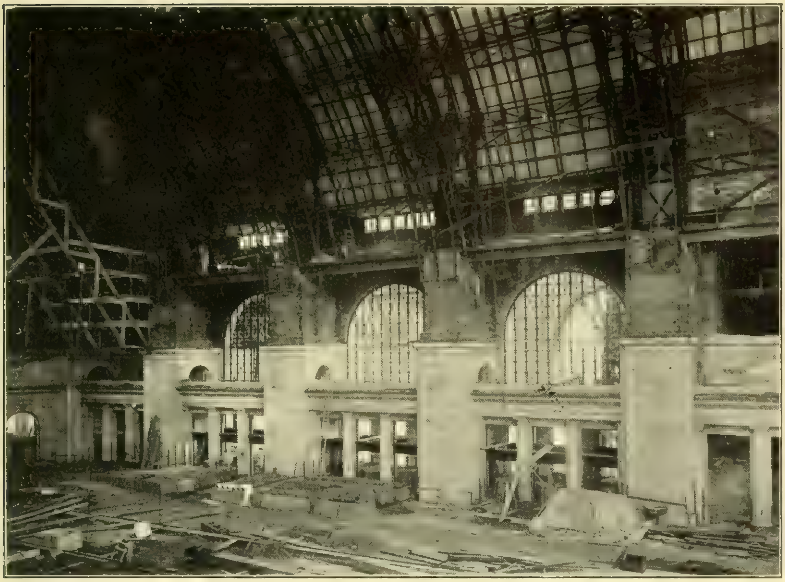


FIG. 1.—WASHINGTON TERMINAL STATION: MAIN WAITING-ROOM. DURING CONSTRUCTION.

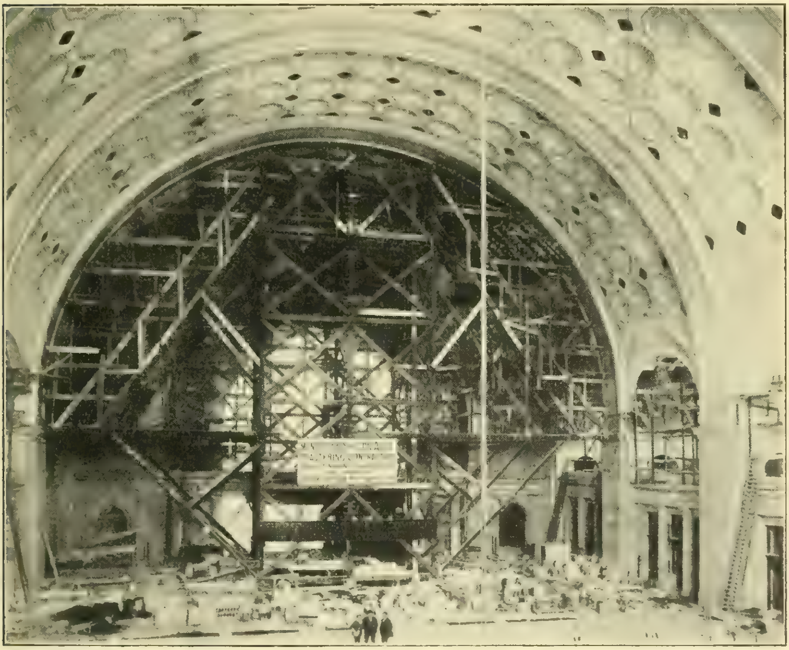


FIG. 2.—WASHINGTON TERMINAL STATION: MAIN WAITING-ROOM, SHOWING TRAVELER USED IN PLACING CEILING COFFERS, ETC.

over the ticket lobby is of glass, and the remainder of the area of Ehret's slag roofing. There are skylights at various points in the area covered by slag roofing.

The concrete tile roof construction was built as follows: Reinforced flat tiles, about 30 by 48 by $1\frac{1}{2}$ in., were laid directly on the skeleton steelwork; the entire roof surface was then covered with roofing felt, for the purpose of providing a water-tight surface; light angles, running longitudinally with the structure, were then bolted to the slabs in order to hold the top slabs in place. These slabs are of the same general dimensions and construction, except that at one end they are provided with a projecting lip or overlap and the other end and the sides are raised. The projecting lip overlaps the upper end of the tile below, and the raised edges forming the side joints are covered with a joint cap. Hydrolithic waterproof compound was used in the upper slabs. All flashing and other sheet-metal work is 16-oz. copper, except in the ceiling light construction, which is of galvanized iron.

Plastering.—All plastering in the station, including the cement plaster ceilings of the carriage porch and train tunnels, was done by McNulty Brothers, of Chicago. The scagliola work in the dining-room was also included in the plastering contract, but was executed as a sub-contract by the American Art Marble Company, of Philadelphia. King's Windsor cement was used in the mortar, and, with the exception of the attic and the ceiling of the concourse basement, was executed in three-coat work, the last coat in all cases being plaster of Paris.

The barrel-vaulted ceilings of the main waiting-room, the alcoves on the north and south sides of the same, and the segmental arched ceiling of the concourse, are composed of sunken coffers cast in gelatine moulds, and are suspended from the lower chords of the steel roof trusses by light channel irons and clamps of various forms. With the exception of some plaster ornamentation in the ceilings of the dining- and lunch-rooms, women's and men's rooms, and state apartments, all the work in the other public rooms and offices is plain.

The faces of all piers in the dining-room are finished in scagliola, the predominating color being light yellow. Flanking the main piers, and resting on ornamental bases of verde antique marble, are scagliola columns, the lower portions of which are cylindrical in section and dark red in color; the upper portions are fluted, and, including the Ionic capitals, are white with veins in imitation of marble. The entire scagliola work was executed in a skillful manner, and finished with a very high polish.

Perhaps the point of special interest, however, and the one which should be emphasized in this paper, was the method of executing the more difficult portions of the plaster work. As stated elsewhere, the ceiling of the concourse is a segmental arch having a span of 130 ft. and a rise of 23 ft. The springing line of the arch is 22 ft. above the floor level of the station and concourse, and the soffit is 45 ft. To execute this work, a light traveler was constructed of sufficient length to extend across the concourse, the top contour of which corresponded approximately with the ceiling curve. It was mounted on small wheels for the purpose of permitting easy movement along the length of the concourse. From this moving scaffold all the ceiling work of the concourse, except the painting of the plaster coffers, was executed.

The ceiling of the main waiting-room is a semicircular or barrel-vaulted arch, the springing line of which is 36 ft. above the waiting-room floor and the soffit 96 ft. It has a clear span of 120 ft. and a total length of 238 ft. To apply the plaster to a ceiling of such proportions of necessity called for a scaffold of unusual size. To avoid the expense of erecting a new and costly traveler, the one used by the Thompson-Starrett Company in the erection of the structural steel was obtained. This structure was originally about 40 ft. square and more than 100 ft. high. To make it available for the purpose, the top section was removed and wings about 40 ft. wide were built on the sides. This produced a traveler about 40 ft. deep and of a width equal to the span of the room. The top contour of the wings consisted of a curve approximating the curve of the ceiling. The large plaster coffers or panels were raised to the top of this traveler by hoisting engines, from which point to the ceiling they were handled by workmen. With this equipment, and a large casting and modeling force, excellent progress was made.

Carpentry and Hardware.—The Meader Furniture Company, of Cincinnati, Ohio, furnished and erected in place all woodwork, supplied all hardware, and did all the painting and finishing of woodwork and plaster in the entire building, with the exception of the painting and decorating of the public rooms, which was done by

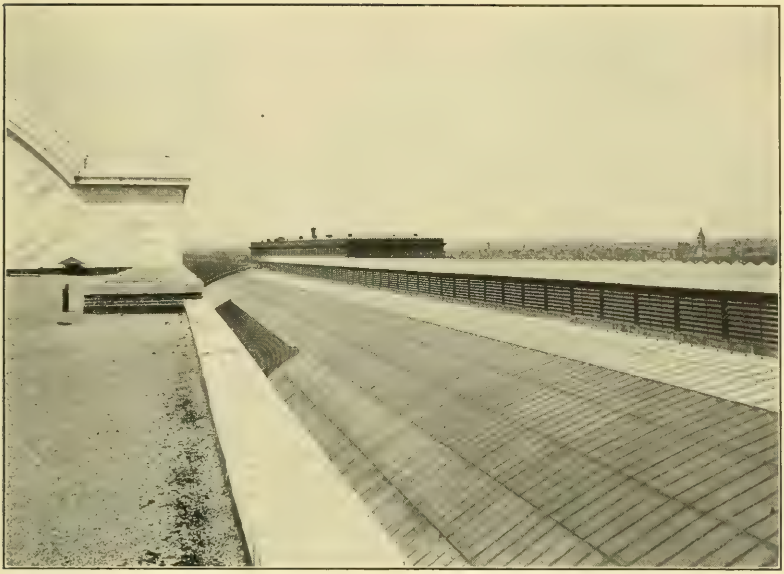


FIG. 1.—WASHINGTON TERMINAL STATION: ROOF OF CONCOURSE.

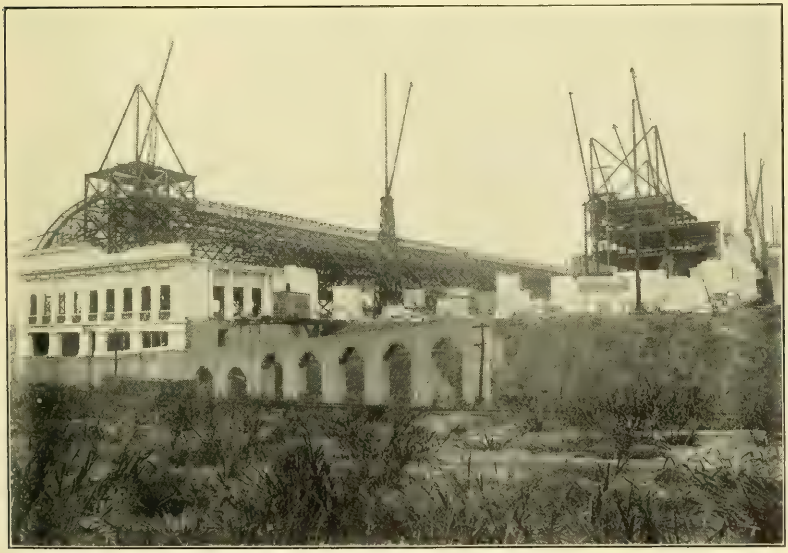


FIG. 2.—WEST END OF WASHINGTON TERMINAL STATION, SHOWING ERECTION OF LAST STEELWORK IN CONCOURSE ROOF.

Joseph F. Sturdy, of Chicago, Ill. The woodwork included all interior and exterior door frames and trims, window frames, sash, and trims, wardrobes, and floors, except where marble and cement were used, and all centers and templets for masonry and terra cotta work.

It also covered the settees for all waiting-rooms, certain cases in the ticket-offices, cases for the storage of supplies, etc., in the ticket-agent's office, and all furniture and fixtures in the ticket-receiver's office and conductors' workroom, except the tables and desk. The settees in the waiting-rooms are of mahogany, from designs furnished by D. H. Burnham and Company, the architects. Mahogany was also used in all interior and exterior doors and interior trim on the main floor. All interior woodwork above the first floor was birch finished in mahogany. All floors were laid with first-quality clear maple.

The painting included all outside and inside woodwork, and outside and inside structural iron except that covered by the ornamental iron contract, together with the painting of all plaster work except as above noted. The plaster work in the baggage checking-room, toilet-rooms, barber shop, and office entrance lobbies on the first floor, and all corridors and toilet-rooms on the second and third floors, were finished with one coat of hard oil and three coats of pure white lead and linseed oil, in light yellow. All other plastered surfaces were painted with one coat of hard oil and tinted in light yellow with the best quality of calcimine. Inside and outside metal-work, except copper, received one coat of mineral paint and two coats of linseed oil and white lead. This includes all exposed pipes, with the exception of steam pipes, which were taken care of by the heating contractor.

All hardware is of No. 2 statuary cast bronze metal, except springs and checks, which are of iron finished to match the hardware. The hardware in toilet-rooms, etc., is nickel-plated. All hardware included in the above contract was furnished by P. and F. Corbin and put in by the Meader Furniture Company.

Cement Work.—The concrete and cement work in the floors of the concourse, the corridors of the main building, the basement baggage-room, and the sidewalks along the front and ends of the station, were constructed by the Rudolph S. Blome Company, of Chicago, Ill. The concourse floor was laid in design; the body was of the usual Portland cement color, and the ornamental portion was colored red by the use of mortar stain. The corridor floors were also laid in design, the ornamental portion consisting of a red border.

The floor of the basement baggage-room and the sidewalks along the front and ends of the building were constructed according to the usual practice, 6 in. in thickness, and laid on a 6-in. bed of cinders. The edges of all sidewalks around the building and the edges of floors around teaming spaces are protected with angle-iron curbs, consisting of 6-in. angles laid with one leg vertical, forming the edge of the platform or walk and secured to the body of the sidewalk by iron clamps. The top finish of all sidewalks and floors consists of 2 parts Portland cement and 3 parts torpedo sand.

The asphalt pavements in the east and west basement driveways and in the east court and carriage porch at the west end were included in the above contract, but executed by the Cranford Paving Company, of Washington, D. C., as sub-contractor. The original specifications for asphalt roadways provided for the use of European asphalts (Seyssel, Neuchatel, etc.), but, owing to their brittleness, and to delay in securing them, it was considered advisable to substitute Trinidad, and the contract was changed accordingly.

Marble Work.—All marble work, except the basin slabs and backs furnished by the plumbing contractor, was furnished and set in place by the Vermont Marble Company, of Proctor, Vt. The floors in the main waiting-room and ticket lobby are of 24-in. white-cornered tile with 6-in. red Champlain dots; those in the men's smoking-room and the women's waiting-room are of 15-in. white tile with 3-in. red Champlain dots; and those of the toilet-rooms, baggage checking-room, telephone-room and drug store are of 12 by 24-in. plain white tile.

The floors in the dining- and lunch-rooms and the barber shop are of 12-in. white tile; those in the state reception rooms are of 12-in. white tile with 3-in. red Champlain dots at intervals of 24 in. The floors of the entrance and exit vestibules are in designs using Glen Falls black, verde antique, red Champlain, and Vermont white. All white tile floors above mentioned, together with risers, treads, and landings of stairways, are of white Vermont marble. All partitions, backs and stiles in toilet-rooms, and trim of smoking-room and office entrances are of light cloud Vermont.

Verde antique is used as a base around the walls of the dining-room and as bases for the scagliola columns. All marble work in the toilet-rooms is supported on and held in place by nickel-plated brass rails, angles, braces, etc.

Sewerage, Drainage, and Plumbing.—The Wells and Newton Company, of New York, furnished all labor and material required in the construction of all sewers and drains, the installation of all piping for cold, hot, and drinking-water systems, and the setting of all plumbing fixtures and appurtenances.

The pipes for carrying wastes of all kinds, laid under ground, are of cast iron, and, except where used in connection with wrought iron, were coated both inside and out, while hot, with coal-tar varnish. All suspended pipes for carrying wastes are of galvanized wrought iron, supported, at intervals of not more than 12 ft., from the beams of the floors below which they are carried.

All cast-iron pipe is standard-weight gas, cast on end, in lengths of 12 ft., with inner and outer surfaces concentric, sound, and free from all defects; and all fittings were made with special reference to the uses to which they were to be put. All wrought iron is galvanized, and of standard weight and dimensions. The fittings were of cast or malleable iron, as the needs suggested.

Brass pipe and fittings are used in the hot- and cold-water systems, and copper pipe and fittings in the drinking-water system. In addition to the granite drinking fountains in the main waiting-room, there are marble fountains in the women's waiting-room and in the smoking-room, and vitreous fountains in the office corridors, all connected with the drinking-water system.

All risers and concealed branches for soil, waste, down-spouts, and trap ventilation are of galvanized wrought-iron, **Y**-connections being used on all water and waste pipes. There are plugged openings on all water, vent, and waste risers at each floor, in addition to the connections necessary for fixtures already installed. There are hand-holes with screw-plugs on all branches at the connections with risers and on all risers at connections with sewers.

All pipes which pass through the roof are flashed with sheet lead, extending not less than 8 in. in all directions from the pipes, and lead soil pipe, $\frac{1}{8}$ in. thick, was placed around each pipe, extending from the sheet lead to the top of the pipe and turning down 1 in. inside. The sheet lead and pipe are joined by a wiped joint.

The house water supply is obtained from four steel tanks of $\frac{3}{8}$-in. material in the attic, each having a capacity of 5 000 gal. below the overflow line. Each tank has a flanged steel drip-pan of $\frac{5}{16}$-in. metal, 4 in. deep and 1 ft. larger in diameter than the tank. Each tank has cast-iron pipe flanges of proper sizes for overflow, equalizing, and discharge pipe connections, and each drip-pan has a 1-in. drain connection. The tanks and pans received two coats of red lead before assembling and two coats of galvanic varnish inside and out after they were in place.

All hot-water, cold-water, soil, and waste pipes are covered with a double layer of wool felt, lap-jointed with insulating paper, with two coats of water-proof paint, and protected by canvas treated with two coats of water-proof paint not acted on by cement or mortar. All pipes in the baggage-room, or other rooms not provided with heat, are covered, in addition to that above noted, with two 1-in. layers of hair-felt alternating with layers of tar-felt, all lap-jointed and protected with water-proof paint.

All exposed pipes in the ceiling of the train tunnel are covered with a double layer of air-cell covering, protected with canvas impregnated with fire- and gas-proof paint, in addition to the covering specified for condensation. The drinking-water pipes are covered with cork 2½ in. thick, bound with No. 18 galvanized wire, and finished with hot asphaltum.

All the toilet-rooms are equipped with siphon-jet, "Columbia," water-closets, made by the Standard Manufacturing Company; they have dark mahogany seats, and the cisterns, where concealed, are of plain wood, lined with copper, and supported on galvanized-iron brackets secured to the marble backs or to the walls. Each cistern is connected with the bowl by a 1¼-in. rough brass flush pipe in the rear of the marble back, and a nickel-plated connection with the bowl in front of the marble. Where closets are set without casings, the tanks are of dark mahogany and are supported on nickel-plated brackets.

Vitreous porcelain-lipped urinals, made by Haines, Jones, and Cadbury, are placed in the marble urinal stalls of all toilet-rooms. These urinals have traps formed in the bowls, and are constructed so that the flush and drain pipes connect from the rear through the marble backs of the stalls. They are flushed by plain wood copper-lined cisterns supported on galvanized-iron brackets, and connected with a concealed water supply. In all cases several urinals are connected to each cistern; in no case, however, are more than four connected to a 3-gal. tank. The wash-basins, slop-sinks, bath-room equipments, etc., were furnished by the same firm. The basins are set in marble slabs supported on nickel-plated legs and standards; in no case, however, are more than three basins set in one slab where basins are set in batteries. The basin cocks are of the self-closing type, manufactured by the Federal Company, of Chicago, and are connected to the hot- and cold-water supplies with ½-in. nickel-plated brass pipe. There are key stops in the hot- and cold-water supplies leading to each basin.

The slop-sinks are enameled-iron, combination trap, standard, 20 by 22 by 12-in., with nickel-plated brass flushing rim, strainer, and double compression, combination flush and supply faucet and supply pipes to the floor. The bath tubs are 5½-ft., enameled iron, with zinc-white finish outside. The shower and needle baths are nickel-plated brass, with all fixtures complete. The faucets in the public drinking fountains are special, made from designs by the architects.

As stated elsewhere, the general marble work in all toilet-rooms was put in by the Vermont Marble Company. The basin slabs, backs, aprons, and sides, where required, were furnished and erected by the plumbing contractor, blue-veined Italian marble being used. The slabs for single basins are 1¼ in. thick, and for more than one, 1½ in. thick, and not less than 22 in. wide.

There are two electric bilge pumps in a pit in the sub-basement for the purpose of draining the sub-basement and the elevator pits, each pump being enclosed in a water-tight tank and capable of lifting 50 gal. per min., about 20 ft. to a basement sewer.

Heating and Ventilation.—The heating and ventilating systems were installed by the Wells and Newton Company, of New York. The entire building except the main waiting-room, ticket lobby, and vestibules, is heated by a two-pipe, low-pressure, direct-steam system. The main waiting-room and ticket lobby are heated by indirect radiation, fresh air being drawn through nests of steam-heated coils and forced to these rooms by fans. After passing through the coils, and before entering the fan chamber, the air is conducted through air-washers, in order to remove dust and other impurities.

These devices consist of large drums, with sheet-metal heads and wooden-frame bodies, covered with burlap. Beneath these drums there are shallow copper-lined tanks with automatic water supply and overflow connections. When in operation, the circumferences of the drums revolve through the water in the tanks, forming a thin film of water in the mesh of the burlap. The air, in entering the fan chamber, is obliged to pass through the burlap covering of the drums. In doing so, the impurities are removed by the film of water. At each revolution the dirt collected is washed from the burlap and deposited in the tanks.

The fans which force warm air into the main waiting-room and ticket lobby are operated by 40-h.p., 200-volt, 3-phase, 60-cycle, constant-speed, Westinghouse, induction motors, at a speed of 840 rev. per min. The air-washers are operated by 2-h.p., 200-volt, 3-phase, 60-cycle, Westinghouse, induction motors, making 1 700 rev. per. min. The coil and mixing chambers, air-washer rooms, and fresh-air intake are of No. 18 galvanized iron with heavy angle-iron frames. The fresh-air intake may be closed with a balanced sheet-iron damper when not in use.

The vestibules are heated by both direct and indirect radiation. There are two radiators, connected with the two-pipe, low-pressure, direct-steam system, in each vestibule, except the east and west ones of the group leading to the concourse, in which there is only one each. In addition to the radiators, connection is made with the fan system used in heating the main waiting-room and ticket lobby. There are also ten ventilating fans in various parts of the building. Seven of these are in the attic of the east end for ventilating the serving-, dining-, and lunch-rooms and the toilets in the east end of the building. Six of them are operated by 2-h.p. motors, the seventh by a 3-h.p. motor.

For ventilating the kitchen and other service-rooms attached to it, there is one fan, operated by a 10-h.p. motor on the floor above. One fan, operated by a 5-h.p. motor in the basement, ventilates the emigrants' waiting-room and toilet in the basement, and the employees' toilet at the east end of the concourse. One fan, operated by a 5-h.p. motor in the attic near the elevator shaft, ventilates all toilets in the west end of the building.

All motors for the ventilating fans are of the Westinghouse induction type, designed for a 200-volt, 3-phase, 60-cycle current. The motors operating the fans for the kitchen and toilet-rooms at the west end have speeds of 1 120 rev. per. min.; all others have speeds of 1 700 rev. per. min. The capacities of these fans range from about 6 000 cu. ft. per min. for those operated by 2-h.p. motors, to 75 000 and 80 000 cu. ft. per min. for those operated by the 40-h.p. motors.

The entire building is heated by exhaust steam from the main power-house brought to the station through the main steam supply pipe in the tunnel in the west wall. The pipes in the station are supported from the main floor-beams, at intervals of about 12 ft., by expansion hangers. All risers are connected at the tops of the supply main, are provided with gate-valves, and are anchored at the main floor line in such a way that all expansion shall be upward. Steam return lines take care of condensation.

Although the system is designed to circulate steam at low pressure, it is the intention to have it circulated at atmosphere or below. This is accomplished by a Warren-Webster vacuum system, the various sub-divisions on the heating system having corresponding subdivisions on the vacuum system. By this arrangment one portion of the system can be closed for repairs, etc., without interfering with the others.

Two 18 by 16 by 16-in. pumps, manufactured by the Knowles Steam Pump Company, return the condensation to the power-house. A 6 by 4 by 4-in. Deane pump takes care of the condensation from the kitchen. Hot water for use throughout the building is furnished by two Toby heaters in the basement.

All radiators are of the American Radiator Company's make, of plain unveiled steam pattern, and are controlled by thermostats put in by the Johnson Service Company. All radiators are connected through the two-pipe system, and graded down from supply risers to return risers, with connections set so as to prevent trapping by the expansion of the risers. Brass shields have been placed between all radiators and the adjacent walls on the first floor.

All pipes in connection with the heating system are covered with moulded asbestos sectional covering, protected by 8-oz. canvas with two coats of anti-flame paint tinted to harmonize with the decorations in the various rooms. The Toby heaters are covered with moulded asbestos blocks, ½ in. thick, supported on ½-in. mesh wire netting, a 1-in. air space being provided between the covering and the heater. All steam pipes in portions of the building not heated are covered with alternating layers of tar-felt, hair-felt, and insulating paper, and protected by canvas having two coats of water-proof paint. The exposed pipes in the train tunnel have a double covering of air-cell, protected by canvas and water-proof paint.

Fire-Proofing.—The fire-proofing or hollow tile work in the station was furnished and set in place by the National Fire Proofing Company, of Pittsburg, Pa. As stated elsewhere, all the floor and roof construction is supported on steelwork consisting of girders and I-beams spaced at intervals of from 4 to 5 ft. on centers. The spaces between these beams are filled with hollow tile arches, generally of segmental form, though some flat arches were used. All skewbacks are of such form as to furnish support for the soffit tiles immediately beneath the lower flanges of the beams. All partitions and corridor walls are formed of tiles, and all columns not encased in brickwork are protected by the same material.

The fire-proofing was set in lime mortar tempered with Portland cement. It may be interesting to note that all the fire-proofing was obtained from the terra cotta works a few miles west of Washington, and was very satisfactory in quality.

Glazing.—The Pittsburg Plate Glass Company furnished all the glass, and did all the glazing except in the skylights and ceiling lights placed in connection with the sheet-metal work in the station building. All exterior glass above the first floor is double-thick, the remainder is polished plate. Plate glass, either clear or chipped, was used for all interior work in the basement and first floor. In the second and third floors crystalline plate is used below the transom line, and double-thick above. The attic glass is all double-thick. There are plate-glass mirrors in the lavatories, barber shop, and toilet-rooms. All glass not held in place by metal or wood is set in putty and secured by glaziers' tacks.

Decorations.—The general painting of plaster and woodwork throughout the station was done by the carpentry contractor. This applied to all work above the first floor and to the wood and plaster work in the private rooms on the main floor. The painting and decorating of the public rooms, however, was done by Joseph F. Sturdy, of Chicago, Ill. The ceiling of the main waiting-room and the alcoves on either side are painted in oil, the color being a light gray, to harmonize with the masonry side walls; the centers of the sunken panels are picked out in gold leaf. The ribs introduced in the ceiling at intervals of about 40 ft. and the arch at the west end of this room are also decorated in gold leaf.

The decorations of the dining-room are detailed from the best examples of Pompeian work. The panels in the alcoves are covered with evenly-woven tapestry burlap painted in oil and ornamented. The center panels are dark red and the side panels dark green; both are finished with ornaments in yellowish brown. The ceiling beams and clerestory walls are covered with decorators' canvas painted in oil in light yellow with ornaments in reds and greens. The enrichments of plaster are gilded with gold leaf and picked out in harmonizing colors.

The paneled surfaces in the lunch-room are covered with tapestry burlap painted in oil and decorated with Pompeian ornament. The ornamental plaster is gilded with gold leaf, lacquered with French lacquer where necessary to obliterate glitter. The general color scheme in the walls of this room is quite different from that in the dining-room as the colors are much lighter, the prevailing tone being light yellow, except that the panels are of a deep brownish yellow with corresponding contrast in ornaments. The coloring of the ceilings and clerestories of the two rooms, however, is very similar.

The panels in the side-walls of the women's room are covered with tapestry burlap painted in designs in greens and browns. The plaster ornaments are picked out in gold leaf. The ceiling is covered with decorators' canvas painted in oil and divided into panels by the use of a light green border treatment with the light cream body of the ceiling.

The general decorative treatment in the smoking-room is smiliar to that in the women's room above described, except as to color. The ceiling of the ticket lobby is painted in light gray, including the plaster and the metal ceiling light frames. The ceiling in the concourse is painted in oil, the color being light cream.

The ceiling of the state reception-room is covered with decorators' canvas, the walls with tapestry burlap, both painted in oil. All moulded work and ornamental plaster is painted in oil. Caps and enrichments are finished in gold leaf. The arched panels in the west side of the room are decorated with conventional ornament in green and brown. The small panels in this wall are worked in tapestry design in soft colors, toned to produce a soft subdued effect. The large panels are gilded with aluminum leaf and decorated with a fret border about 6 in. wide, designed so as to avoid stiffness. The prevailing colors in this suite of rooms are brown, dull gold, brownish blues, and soft reds, interwoven so that no one color asserts itself.

Terra Cotta.—All exterior masonry and the interior walls and piers of the open porticos are of granite. The domes of the central and end pavilions, the loggias connecting them, and the east portico are of terra cotta, the texture and color being made in imitation of the surrounding granite. The section of the hemispherical dome above the door leading to the state apartment is also of terra cotta with color and texture as above, but with an entirely different architectural treatment.

The interior walls of the concourse are lined with white enamel brick, with base, window and door trims, and cornice of enamel terra cotta of the same color. The lintels and sills of windows opening on the light courts, the copings on the tops of all brick walls carried to the roof line, and the architectural features in the baggage checking-room walls are of semi-glazed terra cotta in colors to harmonize with the adjoining brickwork. The settings for two of the clocks on the concourse and the large clock in the main waiting-room are also of terra cotta, in color to suit the adjoining masonry. The terra cotta was furnished and erected complete by the Atlantic Terra Cotta Company, of New York.

Ornamental Ironwork.—All ornamental iron and bronzework was furnished and erected by the Chicago Ornamental Iron Company, of Chicago, Ill. The ornamental cast-iron work was made from the best brands of soft Superior and Southern pig irons, and includes the train fence on the concourse and all ornamental ironwork on the outside walls of all structures on the concourse, the metal-work holding the glass in the windows of the main waiting-room, a portion of the metal-work in the stairs, and the grilles used in connection with heating and ventilation. It also includes the cast-iron doors for electric cut-out boxes, pipe shafts, and dumb-waiters.

The ornamental wrought-iron work includes the balustrades of the stairways and stairwells, the stringers supporting the stairs and platforms, the wrought-iron wind bracing in the large windows of the main waiting-room, the grilles in the elevator enclosures, the rolling shutters at the east and west concourse basement entrances, window guards, gas-pipe railings, baggage chutes, and the boiler-plate guards around columns in the baggage-room.

All fine ornamental iron castings were made in stove-plate moulding sand. All ornamental details were specified to be moulded in clay and then cast direct from the plaster reproduction of the clay model, instead of from wooden patterns. All ornamental ironwork on the stairways, except railings and balustrades, is painted black, the railings, balustrades, elevator enclosures, and ornamental iron in the elevator cabs are finished in Bower-Barff.

The bronzework covers the thresholds in openings where ornamental iron frames are used, kick-plates on doors of public rooms of the station, the bronze grilles in the ticket-office, and the bronze racks in front of the ticket-office windows.

Miscellaneous Facilities.—Attention is now called to the details of the general telegraph office, the telephone exchange, the telautograph systems, rest and recreation quarters for the trainmen, the cleaning system, the clock system, U. S. Mail facilities, and the equipment of the dining- and lunch-rooms, kitchen, serving-room, etc.

Telegraph Service.—The telegraph lines from the north and south are brought to the station through underground terra cotta and fiber ducts, the duct system extending as far north as the north side of New York Avenue and south to the south portal of the First Street Tunnel. The ducts north of the station are laid in a concrete cradle in a trench between the tracks, those south in the masonry walls of the tunnel. There are manholes at intervals of 300 or 400 ft. throughout the system.

The terminal-rooms, where the cables terminate and the building wires begin, are in the basement. One room contains the Baltimore and Ohio Railroad and the Western Union wires, the other the Pennsylvania Railroad, Postal, and Washington Terminal wires. There are two motor-generator sets for supplying 60-volt, direct current for use in the operation of the Pennsylvania Railroad wires, and two sets for supplying 6-volt, direct current for use in the operation of the Washington Terminal local wires. These currents are stepped down from the 220-volt alternating current of the power circuit.

The general telegraph office is on the third floor at the east end of the station, and is equipped with a 50-jack-board and three tables.

The jack-board is capable of taking care of 50 loops or 100 single wires. There are now 32 loops in operation, 6 leading to "A" tower, at the north entrance to the tunnel, 10 leading to "K" tower, in the throat of the train yard, and 16 to "D C" office, on the concourse adjacent to the station-master's office. Communication with "C" tower, at the throat of the coach yard, is established by direct connection with the main-line wires at that point.

Each table has 8 instruments and 2 jack-boxes, the equipment being sufficient to accommodate 24 men in case of emergencies. Connection is made in the station with the Western Union and Postal wires, so that in cases of necessity they can be pressed into service.

Telephone Service.—The Chesapeake and Potomac telephone cables enter the terminal property at H Street, from which point to the terminal-room in the station they are carried through the fiber ducts of the telegraph conduit system. The terminal-room is in the basement adjacent to the telegraph terminal-rooms, and contains, in addition to the Chesapeake and Potomac wires, the wires of the Terminal Company and the police and fire-alarm lines leading to the police and fire-call boxes at the station.

The exchange is adjacent to the telegraph office, and contains a four-position board capable of taking care of about 300 branches. Branches have been run from this board to all parts of the terminal property and joint coach and engine yard, 95 having been installed to date. In addition to the branches above noted, trunk-line wires belonging to the Pennsylvania Railroad Company are connected with the above board as follows: One each to Baltimore, Md., Wilmington, Del., and Philadelphia, Pa.; two to the Potomac freight yard near Alexandria, Va.; two to the P. B. & W. freight yard exchange at 4½ Street and Virginia Avenue, and one to the city ticket-office.

A motor-generator set furnishes ringing current for the telephones in case of failure at the main telephone office. There is also an 11-cell storage battery, for use with the telephone system, and for operating the motor-generator.

Telautograph System.—On account of the size of the terminal station and train yard, and the consequent distance between the various offices, prompt communication would have been impossible without some system less troublesome than the telephone or telegraph. To meet this condition, the Gray National Telautograph Company, of

New York, furnished and put in two separate systems, one for reporting from "K" tower the time of arrival of trains, the other for communication between the dining-room, serving-room, and kitchen.

There is a transmitter and pilot receiver in "K" tower, and connected with it there are three receivers on the train fence, one in the bureau of information, one in the station-master's office, one in the baggage-room, one in the inspectors' room for the low-level tracks, one in the Adams Express office, and one in the United States Express office. Later, an additional transmitter was placed in the station-master's office and connected with all receivers, for the purpose of augmenting the service by giving additional information through the station-master's office. When one transmitter is in use the other is locked in such a way as to prevent disturbance. The operator at "K" tower obtains telegraphic advice regarding the movements of in-bound trains. The reports are then transferred to the transmitter in the operator's handwriting, and at the same instant copies of the report appear at all the receivers on the system.

In the dining-room, orders are transferred to the transmitter, and, as they are written, copies appear simultaneously at the receivers in the serving-room and kitchen, thus insuring quicker service and fewer mistakes.

Comfort and Convenience of Employees.—One of the most attractive features in this terminal is the provision made for the comfort and convenience of men whose duties require them to enter and leave the terminal at all hours of the day or night. To meet this need, more than 20 000 sq. ft. of floor space in the upper floors of the east end of the station have been set aside for the use of employees, and arranged as reading-room, social hall, assembly-room, bowling-alleys, gymnasium, and sleeping quarters.

The furniture and equipment necessary to fit up these quarters was provided by the Terminal Company, but, to make the department semi-self-supporting, a nominal charge was fixed for facilities afforded, and the management was placed in charge of the Railroad Young Men's Christian Association. The charges are as follows: Membership fee $5 per annum; use of beds, 10 cents per night; use of lockers, 50 cents and $1 per annum. A nominal charge of about half the regular price is made for the use of pool and billiard tables and bowling-alleys. All other privileges, including baths and athletic features, are free to members.

The baths consist of tub, needle, and shower, and are maintained in exceptionally cleanly and sanitary order. The sleeping-rooms are equipped with iron cots, with good springs and mattresses. All facilities are open day and night, and the men are called at any hour they may designate, a clerk being continuously on duty for that purpose. The sleeping-rooms were removed as far as possible from the recreation and social rooms, so that the occupants' rest would not be disturbed by noises. The reading-room is supplied with daily, weekly, and monthly periodicals, covering all classes of reading. There are on the tables at this time about 35 daily papers, 30 weekly, and 37 monthly magazines.

Cleaning System.—The Dunn-Locke Vacuum Cleaning Company, of New York, placed in the basement of the station building a plant for cleaning and scrubbing the floors of the offices and public rooms in the station and concourse. It consists of two steam-driven air pumps having cylinders 9 by 22 in. with a stroke of 12 in., each having a capacity to operate 16 renovators at one time from any 16 outlets.

From the suction outlets of the saturating chambers of the vacuum machines, in the basement under the east end of the main waiting-room, there is a 4-in. galvanized main header line, to which each of the ten vacuum risers in the head-house proper, put in by another contractor, is connected. A connection is also made with the lines under the concourse floor. The exhaust line is connected with the heating system of the station. There are eight separate water lines in connection with this system, six on the concourse and two in the general waiting-room.

The plant discharges directly into the sewer, thus avoiding the necessity of cleaning the collection tanks. On all floors throughout the station there are ¾-in. connections with the various risers, and 1-in. connections on the concourse.

The equipment furnished with this plant consists of 600 ft. of 1-in., non-collapsible, steel-ribbed hose, in 50-ft. lengths, for use on the concourse; 600 ft. of ¾-in., non-collapsible, steel-ribbed hose, in 50-ft. lengths, for the interior of the station; twelve carpet renovators; twelve bare-floor renovators; twelve renovators with mop; twelve

4-in. hand renovators for tapestry, furniture, etc.; twelve rubber-corner renovators; twelve 4-in. hard brushes for woodwork; twelve 8-in. wall brushes with short handles; and twelve 3-piece extension tubes.

Clock System.—The Magneta Company, of New York, installed in the station and concourse a clock system known as the Magneta electric, consisting of a master-clock and ten secondary clocks. The master-clock is in the telegraph office on the third floor of the station. It is wound by an electric motor, the current for operating it being obtained from the main power-house. It is of the standing type, with mahogany case, and has a self-winding device and a Reifler compensation pendulum.

Of the secondary clocks: there is one at each end of the concourse, each having a 5½-ft. dial; one over the station-master's office in the center of the concourse, with a 2¾-ft. dial; one in the transom space over the middle door between the ticket lobby and the carriage porch, having a 3 ft. 2-in. dial; one over the marble mantle in the smoking-room, with a 2¾-ft. dial; one in the east end of the baggage checking-room, having a 5-ft. dial; one in the east end of the main waiting-room, with a 6¼-ft. dial; one in the east end of the women's waiting-room, with a 3-ft. dial; one in the west end of the dining-room, with a 3⅓-ft. dial; and one in the west end of the lunch-room, with a 3 ft. 7-in. dial.

The settings for all the secondary clocks are special, and were made from the designs of the architects. The architectural treatment of the settings is in harmony with the surroundings. The clocks on plaster walls are set in plaster trims. Those used in connection with ornamental iron are set in frames of that material. The smoking-room clock is set in the marble trim above the mantel in a bronze frame. The large clocks in the east and west ends of the concourse and in the east end of the main waiting-room are set in ornamental terra cotta.

All secondary clocks have standard electrical movements, and are actuated by the master-clock, which not only operates the dials but keeps them synchronized at all times. All clocks are operated on half-minute intervals.

Mail Chutes and Boxes.—The Automatic Mail Delivery Company, of New York, furnished and put in two mail chutes with collection boxes in the office entrances, two collection boxes on pedestals in the main portico, and two collection boxes on the concourse, supported on brackets attached to the north wall of the head-house. The chutes are of glass and sheet metal held together with metal frames and ornamental mountings, supported in position by angle irons attached to the building construction.

The chute in the east office entrance extends from the collection box on the main floor to a point about 4½ ft. above the fourth or attic floor; that in the west entrance extends to a point 4½ ft. above the third-story floor. The entire equipment is in bronze. The two boxes at the bases of the chutes in the office entrances are finished in Bower-Barff, to harmonize with the ornamental ironwork of the stairways and elevator enclosures, the remainder in antique brushed brass.

Cab Service.—In order to have all facilities up to the standard of convenience inaugurated in the construction of this terminal, a taxicab service was established by the Terminal Taxicab Company to replace the cab service operated by horses at the old stations. This company operates its cabs under a contract with the Terminal Company, paying for its concession a percentage of its receipts, the same as other companies or individuals holding concessions in the station. To some extent, the Taxicab Company bears the same relation to the Terminal Company that the horse-cab service did to the railroad companies, in that its operation on the terminal property is controlled by the Terminal Company.

Dining- and Lunch-Room Equipment.—The counter and stools, cashier's desk, and oyster-shucker in the lunch-room were supplied and erected in place by William Grey and Sons, of Philadelphia, Pa. The furniture in the dining- and lunch-rooms, consisting of a checker's desk, 24 serving tables, 44 dining and lunch tables, and 236 dining chairs, was supplied by the A. H. Andrews Company, of Chicago, Ill.

The lunch counter and cashier's desk have galvanized-iron frames, verde antique counter tops and bases, and light cloud Vermont dados, the former having a bronze foot-rail. The oyster-shucker has nickel-plated legs, and is of light cloud Vermont marble. The 57 stools for the lunch counter have bronze standards and mahogany seats, the base being anchored to the marble floor. All furniture in the lunch- and dining-rooms is of mahogany, upholstered in Spanish leather.

Kitchen, Store, and Serving-Rooms Equipment.—The shelving, tables, lockers, wardrobes, dish-racks, etc., in the kitchen, storerooms, and service-rooms of the station, and the wire-mesh partitions and window screens for these rooms were furnished by the Wayne Iron Works, of Philadelphia, Pa. The former equipment is of sheet metal, the latter is of galvanized-iron wire with channel-iron frames.

The kitchen, storerooms, pastry-room, butcher shop, etc., are on the second floor, immediately over the state suite, and the serving-rooms are on the main floor, adjoining the dining- and lunch-rooms. These rooms have been supplied with the latest and most improved cooking apparatus and fixtures by the Duparquet, Huot and Moneuse Company, of New York, the equipment being sufficient to supply the crowds for which Washington is frequently required to cater.

Refrigerators.—Refrigerators for the dining- and lunch-rooms, serving-room, and kitchen were furnished and erected by the Lorillard Refrigerator Company, of New York. The entire system comprises 27 refrigerators of various sizes distributed throughout the restaurant layout, including the east basement, lunch-room, serving-room, storerooms, and kitchen, as shown in Table 1.

TABLE 1.—REFRIGERATORS IN WASHINGTON TERMINAL STATION.

Number of refrigerators.	Consecutive number.	Name.	Dimensions.						Capacity in Cubic feet.	Number of coils.	Temperature, in degrees, Fahrenheit.
			Length.		Width.		Height.				
			ft.	in.	ft.	in.	ft.	in.			
1	1	Cold Storage, A " " B	25	6	23	3	11	0	6 521	4 8	34° 28 to 40
1	2	Fish	4	0	3	0	3	4	40	1	34
1	3	Baker's	5	0	3	6	7	0	122	1	38
1	4	Order	5	0	3	6	7	0	122	1	34
1	5	Salad	6	0	3	0	2	6	45	1	40
1	6	Serving pantry	10	0	3	6	7	0	245	2	38
1	7	Milk and cream	16	9	2	9	3	2	145	1	38
1	8	Ice cream	......		......		......		....	1	8 to 10
1	9	Buffet	14	0	3	0	3	1¼	140	3	32 to 38
1	10	Oysters	5	0	3	6	7	0	122	1	36
3	11	Milk	2	3	1	5	2	9	....	No coils	....
3	12	Butter	2	9	1	3½	2	9	....	" "	....
3	13	Cream	2	2	1	5	2	9	....	" "	....
1	14	Milk	3	0	3	0	3	6	....	" "	....
1	15	Butter	3	0	1	6	3	6	....	" "	....
1	16	Cream	3	0	2	0	3	6	....	" "	....
1	17	Milk storage	5 ft. 10 in. front, 4 ft. 6 in. right end, 5 ft. 0 in. left end, 5 ft. 0 in. high						210	2	34
1	18	Ice cream storage	6	2	3	4	2	10	58	1	8 to 10
1	19	Ice storage	16	6	8	0	8	0	1 056	1	32
1	20	Garbage	10	7	10	0	8	0	840	3	28
1	21	Caraffe freezer	12	0	7	0	9	2	770	20	To suit.
			raised on 10 in. bearers, making 10 ft. 0 in. over all								

Refrigerators Nos. 11 to 16 are cooled with ice, the others with coils connected with the brine system of the refrigerating plant. The walls of Nos. 1 to 8 and 17 to 20 were constructed as follows: Exposed outer sheathing of ash, "ship finished," layer of water-proof paper, tongued and grooved spruce running in the opposite direction to the outer sheathing, layer of water-proof paper, boiler hair-felt, layer of water-proof paper, tongued and grooved spruce running longitudinally, layer of water-proof paper, and inner sheathing of tongued and grooved spruce running vertically.

The front of Refrigerator No. 1, in the butcher shop, was furred and wire-lathed, but plastered by another contractor, the doors and frames being set forward to compensate for the thickness of the lath and plaster. The construction of Nos. 9 and 10 was similar to those above described, except that mahogany, finished and paneled to match the surrounding woodwork, was used for the exposed outer sheathing. No. 21 was constructed of two sheathings of spruce and water-proof paper, and a layer of hair-felt 1¼ in. thick, in addition to the wall construction of the above refrigerators. Nos 11 to 16 were constructed as follows: Exposed outer sheathing of mahogany, finished and paneled to match the trim of the surrounding woodwork, layer of water-proof paper, boiler hair-felt, layer of water-proof paper, inner sheathing of tongued and grooved spruce, and lining of 18-oz. copper.

In all refrigerators having special concrete floors the lower edges of the insulating walls were covered with copper turned up on either side of the walls from 6 to 15 in., with the upper edges let into the wood. The floor of No. 1 was constructed as follows: The general floor construction of the room was brought to a level of approximately 1 in. of cement concrete thoroughly water-proofed, followed by 1-in. boards, cork-pitched, layer of water-proof paper with the joints well lapped and pitched, 1-in. board cork-pitched, layer of water-proof paper with the joints pitched, 1-in. board cork-pitched, and finished with approximately 3 in. of cement concrete properly graded to drains. The concrete was then covered with hexagonal vitrified white tile, properly laid, with a sanitary tile base around the outer walls of the compartment. In Nos. 17, 19, and 20 the concrete was covered with asphalt reinforced with armor plate. The floors of the other refrigerators were constructed in the same manner as the walls. On the copper bottoms specified for Nos. 3, 4, and 6, vitrified white tile was set in waterproof cement.

The doors have solid ash frames, double rabbeted, and insulated in the same manner as the walls, except the doors in No. 5 which are light slide covers, and the doors in Nos. 1, 19, 20, and 21, which are special Lorillard lap doors. The door sills in Nos. 1, 17, 19, and 20 are of heavy cast iron, tinned. The inner walls of the refrigerating pipe and coil lofts are protected against frost by the use of 18-oz. copper, tinned on one side. The floors of Nos. 3, 4, 5, and 6 are covered with 18-oz. copper, flashed to suitable height on the inner face of the walls. There are suitable tinned-copper drip-troughs under all refrigerating pipes, to collect moisture due to condensation and carry it to a drain in each refrigerator.

The storage compartments in Nos. 1 (except the vegetable compartment), 3, 4, and 6 are lined throughout with $\frac{5}{8}$-in. opal glass. The interior of No. 9 is lined with clear seasoned spruce, finished and shellacked. The interior of the vegetable compartment in No. 1, and Nos. 2, 5, 7, 8, and 10 to 21 are lined throughout with 18-oz. copper, tinned on one side.

The meat compartment in No. 1 has two sets of hook rails and supporting standards, with removable tinned meat-hooks, together with tiers of shelves constructed of pipe and angle iron heavily galvanized after fabrication. The shelves and shelf bearers in Nos. 3, 4, and 6 are of solid aluminum. There are wooden shelves for the storage of bottled goods in No. 9, and three tiers of shelves, of sheet metal heavily tinned, in No. 21.

Soda Fountain.—The soda fountain in the drug store was furnished and erected by the L. A. Becker Company, of Chicago, Ill. It consists of the fountain counter, with all necessary appurtenances, including a carbonating apparatus in the basement, and a back-bar or cooling compartment fitted to the circular wall of the room and over the window sill in front of which it is placed.

The fountain has a frontage of 9 ft. 8 in., is 4 ft. 8 in. deep, and 3 ft. 4 in. high. It is constructed of white Vermont marble with a 12-in. base and a 4-in. frieze of verde antique. All joints in the body are covered with white marble pilasters. The counter slab is $1\frac{1}{4}$ in. thick, and of such shape as to accommodate the syrup system. The refrigerator or cooling compartment is of white Vermont marble and has a 4-in. base and frieze of verde antique. The top slab is $1\frac{1}{4}$ in. thick, and is fitted over the granite window sill.

The two draft stands are of Becker's "Octagon" design, and are of selected and highly polished Mexican onyx. Each is fitted with one soda and two mineral water arms with brushed brass finish. The draft stands are provided with Becker's duplex circulating cooler system, which utilizes the carbonated water as a cooling agent and prevents the water in the leader pipes from becoming warm. Each draft arm leader pipe has an independent cut-off valve, allowing the operator to shut off the carbonated water supply from any draft arm at will.

All exposed interior work is faced with white Vermont marble trimmed with 16-oz. German silver. The basins have double reinforced concave bottoms, with undershot water inlets. There are eight 1-gal. syrup containers of vitrified sanitary porcelain, all fitted with Becker's dripless syrup pumps of Britannia metal heavily silver plated. All metals coming in contact with the syrups are 98% pure aluminum, non-corrosive, and immune from the action of fruit acids. There are also four ½-gal. crushed-fruit bowls and two compartments for ice cream.

The coolers furnished with this fountain are known as Becker's Reliable, and are of heavy seamless drawn copper with inner linings of pure block tin of sufficient weight to outlast the life of the apparatus. The refrigeration for the fountain and cooling compartment is supplied from the regular refrigeration system in the station, its source of supply being the refrigerating plant in the main power-house.

The cooling compartments are constructed of six layers of unlike materials, of different densities, for retarding and dissipating the heat. The walls are double, each composed of properly treated woods covered with layers of moisture-proof fiber board. The air space between them is filled with degummed flax fiber.

Lighting.—Although occupying the central portion of the station, the general waiting-room is supplied with abundance of natural light through semicircular windows in the north and south sides and the east end of the room, and through the glass roof over the ticket lobby at the west end. There are five windows on the north side and three on the south side, each 27½ ft. in diameter, and one in the east end 72½ ft. in diameter. The light admitted through the roof of the ticket lobby at the west end is equivalent to that received through a window 50 ft. wide and 60 ft. high. Considerable light also enters through the vestibules in the north and south sides of the room immediately under the semicircular windows. On account of the unusual size of this room, particularly the height of the ceiling, a special lighting scheme was adopted.

In the design of this room provision was made for concealing the lamps and other equipment for artificial lighting. This was accomplished by providing ten alcoves along the north and south sides of the room immediately over the vestibules and in front of the 27½-ft. windows, and over the drug store and telephone-room, each 29½ ft. wide. In each alcove, behind a parapet, there is a bank of especially constructed, inverted, series, arc lamps, with corrugated-mirror reflectors about them to throw the light to the ceiling, whence it is reflected to the floor. The original scheme called for 18 lamps in each alcove, divided into three groups of 6 lamps each. Upon making experiments, looking to a uniform distribution of the light, it was found desirable to reduce the number in each alcove to 14, or two groups of 4 lamps each and one of 6, making a total of 70 lamps on each side, instead of 90, as originally intended.

In addition to the 140 lamps in the north and south alcoves, it was found necessary to place 8 lamps at the west end of the room and 14 at the east end, to produce an effect at night similar to that produced by natural light through the large window in the east end and the glass roof over the ticket lobby in the west end of the room. These lamps are above the colonnades, those at the west being at the north and south ends or above the bureau of information and stop-over ticket-office, while those at the east are distributed along the entire length. To soften and reduce the bluish-white glare of these arc lamps, light yellow-tinted cathedral glass screens are placed over them, and reflectors. Although this causes a loss of about 15% in their efficiency, the results are very gratifying.

This lighting equipment, consisting of 162 lamps, is connected so that several combinations can be had, throwing in by switches as many lamps as required. In addition to the arc lighting, there are 21 incandescent lamps in the ceiling of the east colonnade and 4 in the ceiling of the west; and floor outlets have been provided for the purpose of placing clusters of incandescent lamps on the backs of seats in the central portion of the room, should additional illumination be required.

Readings were taken with a luxometer for the purpose of getting the results of the various combinations. The tests showed that the corrugated reflectors and light colored ceiling produced almost perfect diffusion. With all lamps burning, readings taken about 4 ft. from the floor gave values of from 2.5 ft-candles in the corners to 2.3 ft-candles in the center of the room. The effect of this system of lighting is most pleasing when entering the station at night. No lighting equipment is visible, and very few shadows or light streaks are seen. The first impression is that the room is lighted by a slightly subdued natural light.

Natural light for the ticket lobby is provided by a glass roof over the entire space. The original scheme for artificial lighting contemplated the use of concealed lighting similar to that in the main waiting-room, but with smaller units placed in a groove or pocket in the side-walls of this room. With this system, however, it was evident that much light would be lost through the glass roof, as no glass could be found which would admit daylight freely, and at the same time prevent the escape of artificial light. After careful study and the necessary tests, it was decided to install Tungsten lamps above the glass ceiling. One 100-watt lamp is provided for each section into which the ceiling is divided, and each lamp has a metal reflector coated inside with aluminum paint. The lamps are arranged on four 3-wire circuits controlled by single-pole switches permitting cutting out one-half of the lamps without disturbing the symmetry of the lighted panels. The illumination in this room averages about 2.3 ft-candles, the quality of the light comparing favorably with that in the main waiting-room. The reflectors are of a special design, and are located so as to direct the light along radial lines, both the ceiling and glass roof of this room being curved. In this installation 225 lamps are used, and, on account of their construction, are suspended vertically.

The baggage checking-room on the north side of the ticket lobby is supplied with natural light by the saw-tooth roof construction, the north incline being glazed and the south being of book tile and composition roofing. In addition to the natural light thus admitted, considerable light enters through the windows in the north wall, facing the concourse. To insure the best results, each lamp has a large reflector, and the hollow tile work in the saw-tooth roof is painted with white cold-water paint. These precautions have resulted in destroying in a great measure color rings and shadows. The illumination in this room averages about 1.8 ft-candles, and, for general illumination, is sufficient, but additional light is required at the desks, where records are kept and checking is done.

Outside of a small amount of concealed lighting in the state apartment, no effort was made to use this method in the other rooms of the station.

Owing to the location of the dining-room (being an interior room at the east end of the general waiting-room), no natural light could be secured from the sides, except through clerestory windows. To provide sufficient natural light, saw-tooth roof construction similar to that in the baggage checking-room was adopted, and to provide for the proper diffusion of the light thus admitted, an artistically coffered ceiling of metal and glass was provided. For artificial lighting, eight ornamental urns are suspended from the ceiling, in each of which are twelve 100-watt lamps on two circuits of six lamps each. Around the sides of the room, on the faces of the large piers, there are twelve ornamental bracket chandeliers, in each of which there are three 100-watt lamps. The alcoves in the north and south sides of the room are provided with ten ceiling fixtures, each containing three 100-watt lamps enclosed in hemispherical holophane globes. In addition to this lighting equipment, there are thirty-nine floor outlets, which will permit the use of electric lamps on the tables, in case additional illumination is necessary.

The lunch-room receives natural light from the clerestory windows and windows opening on the concourse. It is supplied with artificial light by six ornamental chandeliers suspended from the ceiling, in each of which there are twelve 100-watt lamps on two circuits of six lamps each, and six ceiling fixtures in the alcoves along the north side, each containing three 100-watt lamps enclosed in hemispherical holophane globes.

The women's waiting-room and toilet, and the men's smoking-room, barber shop, and toilet, face on the open portico extending across the front of the station, and, having large windows, are amply supplied with natural light. Artificial light in the women's waiting-room is furnished by three ornamental chandeliers suspended from the ceiling, in each of which are twelve 100-watt lamps on two circuits of six lamps each, and by nine wall brackets surmounted by holophane globes 14 in. in diameter, in each of which are four 50-watt lamps. The smoking-room is artificially lighted by two ornamental chandeliers and ten wall brackets similar to those in the women's waiting-room. All the chandeliers and wall brackets are of solid bronze, finished in verde antique.

The state apartment faces the east portico, and is well supplied with natural light. Artificial light is supplied both by concealed and exposed methods. In the reception-room three handsome chandeliers are suspended from the ceiling, and each contains twelve 50-watt and six 100-watt lamps, and there are eight ornamental wall brackets surmounted by holophane globes, each containing four 50-watt lamps. The main entrance to the state apartment and the vestibules are lighted in a very satisfactory manner by concealed incandescent lamps with reflectors in the coves in the cornice at the springing line of the arches.

The open portico extending across the front of the building, the east portico, and the carriage porch are artificially lighted by ornamental bracket chandeliers on the interior faces of the piers forming the sides of the portico or colonnade, and by ceiling fixtures in the domes over the central pavilion, the domes south of the drug store and telephone booths, and the domes in the east portico and carriage porch. On the faces of the piers in the main entrance there are twenty bracket chandeliers, eight of which contain six 125-watt and one 187-watt lamps each; the remaining twelve contain three 100-watt lamps each. In the three domes over the main entrance there are ceiling fixtures, 5 ft. 8 in. in diameter, each containing six 100-watt lamps. The ceiling fixtures in the domes of the east portico and the domes south of the drug store and telephone booths are 3 ft. 6 in. in diameter, and contain six 100-watt lamps each. In the state entrance there are twelve bracket chandeliers, each containing three 100-watt lamps, and one dome fixture, 5 ft. 8 in. in diameter, containing six 100-watt lamps, while the carriage porch has thirty-six bracket chandeliers, each containing three 100-watt lamps. In the remainder of the south portico and in the east portico there are fifty-five bracket chandeliers, each containing three 100-watt lamps. All these fixtures are of massive bronze, finished in verde antique. The efficiency of the various fixtures was regulated by the requirements in the different sections of the portico.

The three vestibules in the south or main entrance to the general waiting-room are lighted with fifty-four "sun-burst" fixtures attached to the granite ceiling panels. The five north or concourse vestibules are lighted by one hundred and twenty fixtures of the same design attached to the granite ceiling in the same manner. The drug store and telephone-room are lighted by ceiling fixtures consisting of 5½-in. holophane globes attached to the granite ceiling by brass collars finished in brushed brass. Ordinary 16-c.p. lamps are used in the above fixtures. The ticket cases and counters, the show cases in the drug store, the news-stand, and the flower booth are lighted by Frink reflectors, arranged so that the lamps are concealed as much as possible. Gem lamps are used in all cases where incandescent lamps are specified.

The fixtures for the offices and toilet-rooms are plain, three-light, brass, ceiling fixtures, painted black, the number in each office depending on the size and shape of the room. The lights are controlled by flush push-buttons on wood mats on the walls. The corridors are lighted by gem lamps encased in 8-, 10-, and 12-in. globes, according to their size.

The lighting of the concourse in the rear of the head-house required quite as much study as any other section of the station, if not more. The space covered by the roof is 130 ft. wide and 760 ft. long. The ceiling is an arch having a span of 130 ft. and a rise of 23 ft.; the height of the ceiling in the center is 45 ft. above the concourse floor. This space is used as a passageway between the train platforms and the head-house, and is lighted by seventy-two arc lamps suspended about 7 ft. below the ceiling. Before deciding on the scheme of lighting, many experiments were made. It seemed desirable to use concealed lighting, and, with this in view, series, direct-current, arc lamps were placed between the ceiling and the skylight roof construction. The scheme proved a signal failure, as the structural steelwork in the trusses cast very pronounced shadows, and the ceiling glass absorbed so large a percentage of the light given out by the lamps, that their location could hardly be determined from the concourse floor.

Flaming arcs were then tried, with much better results, on account of the great volume of light produced, but these lamps were abandoned owing to the difficulty and cost of maintaining them in the position in which they were placed. They also produced a very yellow light, which was out of harmony with the general colors in the other parts of the building, although it is claimed that this defect could have been remedied. A serious objection to concealed lighting, however, was the tendency to flatten or nullify the ornamental plaster panels in the ceiling, particularly in the central section which is farthest from the floor.

Large diffusers, containing four or five units, were then tried, but were abandoned on account of objectionable shadows and streaks in the ceiling, due especially to the fact that the ceiling was not designed to accommodate lighting fixtures of that kind. The results would probably have been more satisfactory had the ceiling been designed to permit placing the diffusers in the ceiling instead of below it. The present system was adopted after the foregoing experiments had failed to produce satisfactory results. Each lamp is equipped with a clear inner globe and an opal outer globe, but, though the lighting is good, the glare or light spots produced by seventy-two arc lamps in one room is anything but pleasing when compared with concealed lighting.

The train signs and track numbers over the gates of the train fence are lighted by incandescent lamps, controlled by switches in cabinets containing the mechanism for operating the time signs of outgoing trains. The signs consist essentially of two square boxes or hoods, a small one for displaying the track number and a larger one for indicating the time of departure of trains. Beneath the latter there is a triangular hood with slots on two sides in which are placed slides containing the names of the principal stations reached by the given train. The small hood for displaying the track numbers is above the larger one. Three sides of the hood are of glass painted white on the back. The track number is painted on the face in black, using figures 3 in. high. At night this compartment is lighted with one 100-watt lamp.

The upper half of the lower hood contains a glass slide on which the word "Depart" is painted in black letters 3 in. high. In the rear of this space there are two 50-watt lamps. Below this slide there is a horizontal slot, 6½ in. high and 15 in. long, behind which are three wheels having copper rims of sufficient width to permit the use of figures 5¼ in. high and 2⅛ in. wide, for denoting the time of departure of trains. White canvas is glued over the openings in order to make them conspicuous in day time; at night the numbers are brought out

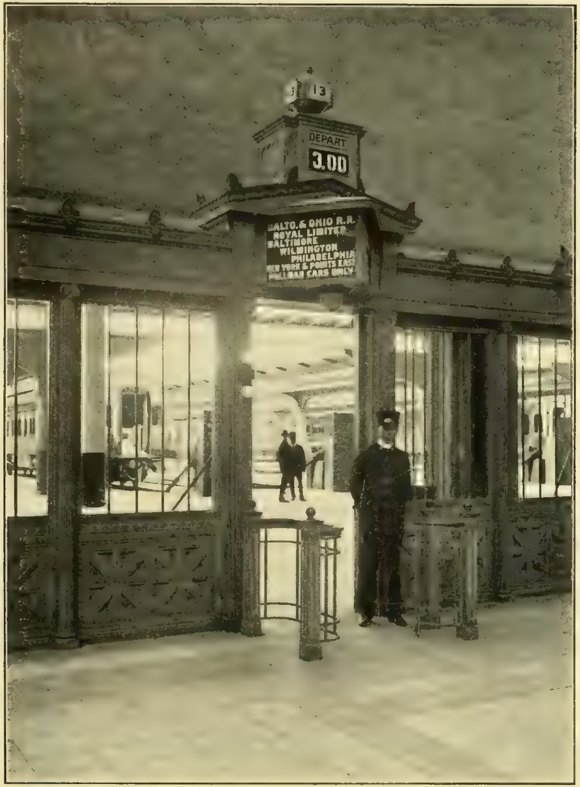


FIG. 1.—WASHINGTON TERMINAL STATION: GATE IN TRAIN FENCE, SHOWING TRAIN SIGN.

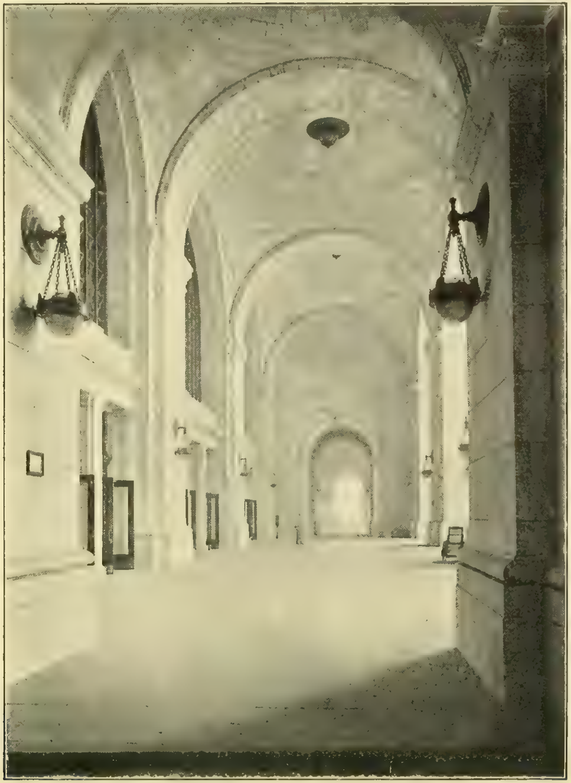


FIG. 2.—WASHINGTON TERMINAL STATION: PORTICO.

by the use of two 100-watt lamps. At the top, and in front of each of the slides indicating the points reached by any particular train, two 50-watt lamps with reflectors have been placed. In the bottom of each triangular hood over the gates there is one 100-watt lamp in a hemispherical holophane globe.

The lighting for the signs and the use of the gateman at each gate is equal to 700 watts, or a total of 22 400 watts for the thirty-two gates. The total lighting equipment on the train fence is equivalent to about five hundred and sixty 16-c.p. lamps.

The train platforms and umbrella sheds are lighted by 187-watt gem lamps placed at intervals of 30 ft., or midway between the supporting columns along the entire length of each shed. The lamps are suspended from the lower side of the central beam forming the roof construction, and each is equipped with a prismatic bowl reflector. The results are very satisfactory.

The power wires furnishing current for the lighting are carried, between the power-plant and station and express building, through vitrified tile ducts in the pipe tunnels in the west retaining wall and under the north sidewalk of H Street. The pipes for elevator, water, and fire service, heating, refrigeration, etc., are carried on supports suspended from I-beams embedded in the concrete roofs of the tunnels, and the vitrified ducts are built in stacks along the walls, with manholes at convenient intervals. There are forty-eight lines of 2-in. ducts between the power-house and the station, and six lines to the express building. All wiring in the buildings is encased in electro-galvanized iron pipe furnished by the Safety Armorite Conduit Company, the smallest size being ¾-in. All short bends were made at the factory and galvanized after the bending had been done. The long bends were made in the field, but, in bending, the use of heat was not permitted.

The high-tension distribution system for incandescent lamps and motors is operated at 2 300 volts and 60 cycles. The transformers for lighting purposes and sets of transformers for motor circuits are served by independent cables direct from the switch-board at the power-house. The arc service cables are of four or eight conductors, and serve two or four loops. All motor-driven apparatus is operated from 3-phase lines, and all incandescent service is taken from one phase of the generator.

The cables conveying current north to the coach yards, shops, and signal towers are lead-covered on account of dampness in the ducts; those south to the station are double-braided, the ducts being reasonably dry. The 2 300-volt cables are insulated with varnished cambric over a thin layer of unvulcanized rubber, and were subjected to a test of 7 500 volts for 5 min. between conductors and ground, after being submerged in water for 24 hours at the factory, and 5 000 volts for 5 min. after being installed. Each conductor in the arc cables is insulated with rubber, with varnished cambric over all, and was required to stand a test of 10 000 volts at the factory and 8 000 volts after installation, under the conditions mentioned above. All high-tension cables were supplied by the General Electric Company.

The necessary transformers, with a ratio of 10 to 1, are housed in brick and concrete vaults at convenient points in the basements of the various buildings, the area covered by the vaults in each case being sufficient to permit changing or making repairs without disturbing the transformers in service. Each vault has asbestos-lined doors, and the necessary locks and keys. The doors are of such size as to permit the convenient handling of apparatus in or out of the vault.

The high-tension cables leading to each transformer terminate in a set of disconnecting switches attached to the wall above the transformer, and there are expulsion plugs between the switches and the transformer. The distributing panels for the low-tension feeders are encased in iron cabinets attached to the outside walls of the vaults on either side of the doors. Connection between the transformers and cabinets is made through iron pipe conduits. From these cabinets three-wire, 113-226-volt feeders are carried to the distributing cabinets located at convenient points in the building, each feeder serving from one to six distributing cabinets.

The distributing panels are encased in sheet-iron cabinets and equipped with three-wire buses and two-wire branches, all controlled by knife-switches, the branch circuits being protected by plug-fuses and buses, and the feeders by type "A" fuses. No switches smaller than 25-ampere rating have been used on branch circuits, or smaller than 150-ampere rating on main circuits.

All insulating joints were entirely eliminated. The neutral wire of the branch circuits is grounded to the conduit system at the fixture outlet and at the cabinet, at the latter by a copper wire connecting the conduit system with each neutral wire. The neutral wire in the feeder circuits is grounded to the conduit system at the cabinets and at the transformers by ground-plates embedded in charcoal under the vault floors.

All secondary wires are insulated by Okonite compound, in accordance with the U. S. Navy Yard and Docks Specifications for low-tension wires. Feeders and tie lines are single-conductor; branch circuits are twin-conductor. Insulation resistance tests gave results from three to twenty times greater than called for by the District of Columbia regulations.

The wiring system for the whole lighting installation, together with a system of conduits for telephone, telegraph, telautograph, and annunciator wires, was put in by A. S. Schulman, of Cincinnati, Ohio, in accordance with working drawings and specifications prepared in the office of the General Superintendent of Motive Power of the Pennsylvania Railroad Company.

Lighting Fixtures.—All lighting fixtures in the station building, except those used in connection with concealed lighting and a few used with Frink reflectors, were furnished and erected by the Sterling Bronze Company, of New York. All special fixtures were furnished complete, including wiring, sockets, globes, shades, and holders, ready to receive the lamps. The office fixtures were furnished complete, except the shades, which were purchased by the Terminal Company direct.

All fixtures, with the exception of those in the offices, are of cast brass, from special designs prepared by the architects. The designs and styles of finish were varied to suit the treatment in the various portions of the structure. The sizes were arranged as far as possible to permit the use of standard shades and globes. The fixtures in the offices and toilets are of the ordinary designs used for such purposes, finished in black oxide.

The horizontal diameter of each of the three fixtures in the state reception room is 3 ft. 6 in. over all; the neat diameter is 2 ft. 6 in. The center of the chandelier is about 16 ft. above the floor and about 12 ft. 8 in. below the ceiling, and is suspended by a heavy brass chain. The small globes around the outside are of holophane glass, and the panels in the large globe are of roughed inside glass, leaded in design.

The three ceiling fixtures in the domes over the central pavilion, and the one in the dome over the state entrance, are 5 ft. 8 in. in diameter, with glass bowls 3 ft. in diameter. To prevent the glass in these bowls from falling in case of breakage, silver wire netting has been placed around them. Five fixtures of this design, 3 ft. 6 in. in diameter, were placed in the domes of the east portico, two in the domes of the south portico opposite the drug store and telephone room, one in the barrel vault between the carriage porch and the ticket lobby, and one in the ceiling of the vestibule between the general waiting-room and the lunch-room. The globes in these lamps are 2 ft. in diameter and are of holophane glass.

The 32 fixtures on the soffits of the train sign hoods over the gates in the train fence are 13 in. in diameter, and have 8-in. holophane bowls.

Side fixtures are attached to the faces of the masonry piers, 12 in the state entrance, 36 in the carriage porch, and 20 in the main portico. The lower globes are of holophane glass, and are 16 in. in diameter; the upper globes are of clear glass, and much smaller. The canopies are 28 in. in diameter, and are secured to the stonework by expansion bolts. There are 55 fixtures of the same design in the south and east porticos, the lower globes in which are 14 in. in diameter, and of holophane glass; the upper globes are of clear glass. The canopies are 22 in. in diameter. There are 12 fixtures of the same design and construction in the dining-room, the dimensions being the same as those in the south and east porticos, except the canopies, which are 28 in. in diameter.

There are 2 hanging lamps in the smoking-room, 3 in the women's waiting-room, 6 in the lunch-room and 8 in the dining-room. The body of each fixture is about 4 ft. in diameter, and is about 10 ft. below the ceiling. The bottom globe is of roughed inside glass in four panels; the glass bowl is 30 in. in diameter, and the upper globe of clear glass.

There are 8 wall brackets in the state reception room, 9 in the women's waiting-room, and 10 in the smoking-room, in which the holophane globes are 14 in. in diameter and the canopies 22 in.

The granite ceiling panels of the south vestibules have 54 fixtures, the north or concourse vestibules 120, the east colonnade 21, and the west 4.

Each of the 41 fixtures attached to the gate posts of the train fence on the concourse, for use in connection with the train starting signal system, has two opalescent globes.

The alcoves of the dining- and lunch-rooms and the office entrances have ceiling fixtures 23 in. in diameter, with 16-in. holophane globes. Fixtures of the same design, 13½ in. in diameter, with 10-in. bowls, were placed in the elevator cabs and passages around the state apartment, 3 in the former and 6 in the latter.

In the corridors of the station there are 135 ceiling fixtures, the globes ranging from 8 to 12 in. in diameter, depending on the size of the lamps used. All the globes on the corridor lamps are of opalescent glass.

In the drug store and telephone-room there are 46 fixtures having holophane globes, 5½ in. in diameter.

The fixtures in the state apartment are finished in rich gilt. Those in the drug store, telephone-room, vestibules, and colonnades are antique brushed brass. Those in the lunch-room, dining-room, women's waiting-room, smoking-room, and all porticos and pavilions, are finished in verde antique, Tiffany color. Those on the train fence, office entrances, elevator cab, and corridors are all finished in black oxide.

Train Yard.

The train yard, immediately north of the concourse, is 760 ft. wide, or equal to the length of the concourse. One-half of the yard is on either side of the center line of Delaware Avenue, which is taken as the longitudinal axis of the depot and train-yard site. The tracks in this space are divided into two groups, one section, 480 ft. wide, containing the stub or high-level tracks, the other section, 280 ft. wide, the through or low-level tracks, leading to the First Street Tunnel.

There are twenty high-level tracks laid singly and in pairs, as shown by Plate CX, and thirteen platforms in the spaces between the tracks, three exclusively for handling baggage, the other ten for both passengers and baggage. On the low-level section, provision has been made for thirteen tracks, nine of which connect with the tunnel tracks, the other four being stub. At present, only eleven tracks are laid, the remaining space being used temporarily for handling mail. This section has five platforms, each 20 ft. wide, for both passengers and baggage.

The platforms for the joint use of passengers and baggage on the high level are 20 ft. wide, and the baggage platforms are 17 ft. At the station end of the latter, there are baggage lifts for handling baggage between the basement baggage-room and the train platforms. The south or station end of each platform on the low level terminates in an elevator used for moving baggage between the platforms and the sub-basement.

In operating the high-level yard, the trains carrying heavy baggage use, as far as possible, the tracks adjacent to the baggage platforms. In this way there is comparatively little interference between passengers and baggage trucks. As no baggage platforms were provided on the low level, on account of lack of space, there is more interference. To facilitate the handling of baggage, having in mind especially the great area to be covered and the long distances to be traversed, there are twelve ½-h.p. electric baggage trucks, constructed at the Altoona shops of the Pennsylvania Railroad Company. The speed and power of these trucks have effected a marked saving in the handling of baggage.

The high-level tracks descend northward on a grade of 0.55% from the station to a point near K Street. The low-level tracks ascend on a grade of 0.8% to the same point. From this point north all tracks ascend northward on a grade of 0.95% to Florida Avenue. At this point the rates of grade on the various tracks change; the Metropolitan Branch to 0.7%; the coach yard to 0.5%; while the Washington Branch of the Baltimore and Ohio and the Philadelphia, Baltimore, and Washington Railroad continue to ascend at 0.95% to 12th Street tower where a summit is reached.

Umbrella Sheds.—The tracks in the train yard are not covered by one large shed, or by a series of large sheds, but each platform has its individual shelter, known as an umbrella shed. Among the reasons leading to the selection of this kind of shelter are the comparatively mild climate and the absence of heavy snows, the cost of erection and maintenance, their desirability on account of cleanliness and light, and because the height of a large shed or series of large sheds would have dwarfed the station and all other buildings in the vicinity.

The umbrella sheds are supported on Ionic columns of cast iron, about 16 in. in diameter at the base, and located at intervals of 30 ft. Each shed on the high level is composed of 23 bays, or 690 ft. in length, which, with the overhang along the north wall of the concourse, gives a shelter for each platform 705 ft. long. The north end of the low-level sheds is opposite those of the high level, but the south end is shortened by the stairways leading from the concourse to the low-level tracks. The roof construction of the shelters is economite

PLAN OF WASHINGTON TERMINAL STATION.

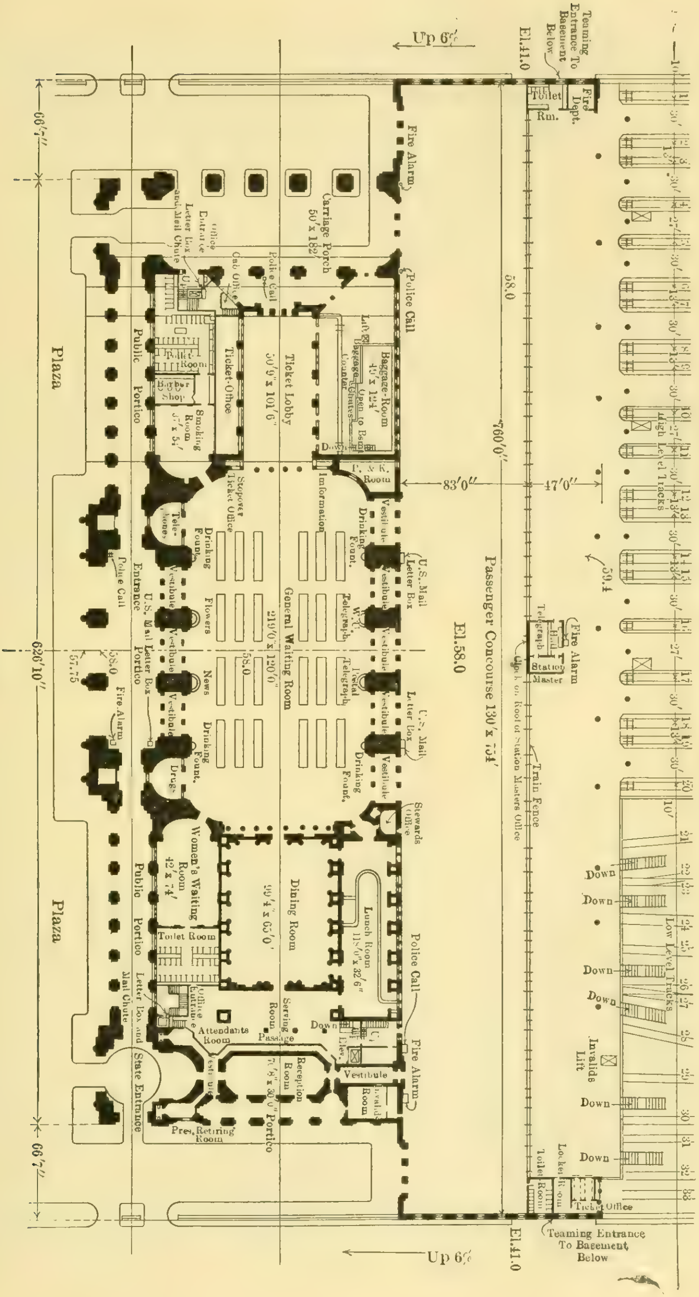


FIG. 2.

tile on wood sheathing, with a 5-ft. continuous skylight on each side of the center line.

The drainage from these sheds is taken care of by cast-iron downspouts in every alternate column, from which it is conducted to sewers by cross-drains under the tracks.

As the space occupied by the high-level tracks was filled to a depth of from 25 to 35 ft. only a short time before the shed construction began, with material ranging from sand to lumps 3 or 4 ft. in diameter, it was felt that very irregular settlement was likely to take place and that the material would not reach its limit of settlement for some years. For these reasons special foundations were necessary.

As the track grades in this section ranged from 54 to 58 ft. above tide, the use of wood piles was not considered prudent. Concrete piles seemed to offer the only solution, as they would not deteriorate in the dry loose fill. The matter was then discussed with representatives of the Raymond Concrete Pile Company. After a careful examination of the conditions under which the work would have to be done and guaranteed, this company refused to consider the proposition for the reason that the Raymond pile, being conical in form, depends largely for its sustaining power on the surrounding earth. Should settlement occur after the pile had been driven, its efficiency would be lost.

The proposition was then submitted to the representatives of the Simplex Company and accepted, as the sustaining power of the Simplex pile depends more largely on the blunt point, which is of the same diameter as the shaft. The load in this case was light, and any settlement of the earth could do no harm unless there should be lateral movement.

Two concrete piles, each about 40 ft. long, were driven for each column, and, at this date, two years after the station was put in service, the alignment of the sheds seems to be as good as the day the work was erected. Piles were not used on the low section, as the fill on this portion of the yard did not exceed 10 ft. in depth, and most of it was deposited about three years before the sheds were erected. On this account, also, concrete platforms were constructed on the low level, but wood was used on the high.

Retaining Walls.—As stated previously, the high-level tracks are on a grade of 0.55%, descending northward to a point near K Street,

PLATE CXVII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
STROUSE ON
THE WASHINGTON TERMINAL STATION.

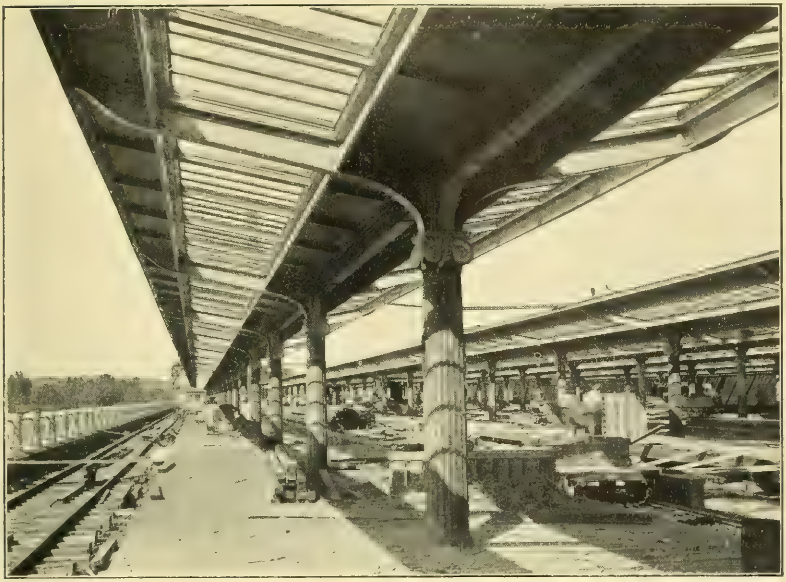


FIG. 1.—WASHINGTON TERMINAL STATION: UMBRELLA SHEDS.

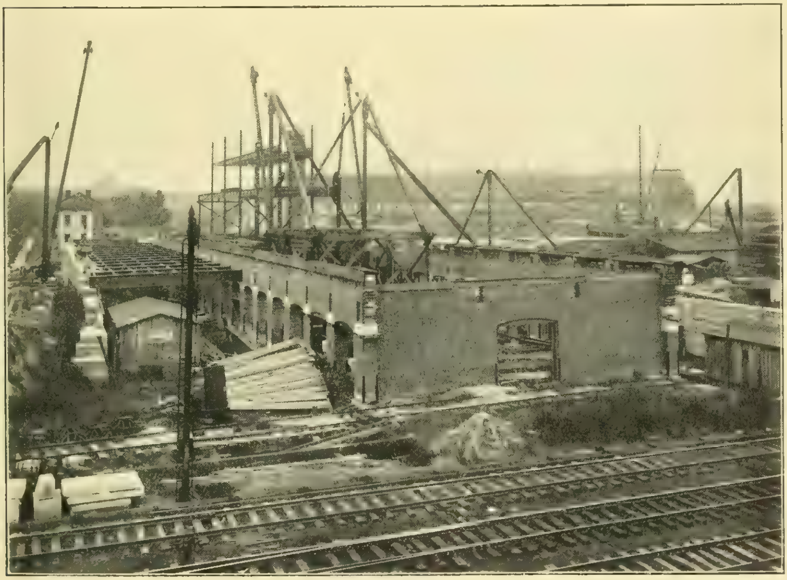


FIG. 2.—SOUTHERN PORTION OF EXPRESS BUILDING, SHOWING TRAVELER USED IN ERECTION OF STEELWORK.

while the low-level tracks are on an ascending grade of 0.8% to the same point. This caused a difference of elevation of 20 ft. at the concourse, and required the high- and low-level tracks to be separated by a masonry retaining wall, extending northward from the concourse to a point near I Street, where the grades practically reach the same elevation.

The entire terminal site, extending from the north line of the concourse to L Street, is enclosed by masonry retaining walls, with cross-walls defining the streets crossed by the terminal construction. There is also a retaining wall in Delaware Avenue between L and M Streets, as required by Act of Congress, for the purpose of preserving the east 40 ft. of this avenue as a public highway. All these walls have a stone facing and Portland cement concrete backing, mixed in the proportions of 1 part cement, 3 parts sand, and 5 parts broken limestone. All ashlar is of Mahoning sandstone, obtained from quarries in West Virginia and Western Pennsylvania; the stone for the concrete was from the limestone quarries of West Virginia.

Both guy and stiff-leg derricks, as best suited the conditions, were used in handling the material for the walls. Where the structure was short enough to be covered by one outfit, the guy derrick was generally used. For the long walls, stiff-legs were generally used, in most cases on runways permitting prompt movement along the line of the work. Conditions beyond the control of the company, however, in many cases interfered with the logical prosecution of the work, consequently, most of the long walls were built piecemeal.

Pipe Tunnels.—There is a tunnel, 12 ft. wide and 13 ft. high, in the base of the west retaining wall, between the station and the power-house, for the purpose of taking care of light and power wires, and pipes carrying steam, air, water, and hydraulic pressure between the power-plant and the station. At H Street it was necessary to depress the tunnel so as to pass under the street; and, on account of the underground trolley tracks, its height had to be reduced to 8 ft.

A branch tunnel, 5 ft. wide and 7 ft. high, was constructed under the north sidewalk of H Street, in which to place the wires and pipes leading to the express building. This tunnel was constructed as a part of the foundation of the north abutment of the H Street Bridge. The wires are cared for in terra cotta conduits built against the sides of the tunnel; the pipes are supported on beams built in the roofs. In the large tunnel I-beams were built in the soffit of the arch at intervals of 10 ft., the lower flanges projecting a sufficient distance below the soffit to permit clamping the pipe racks to them. T-rails were used in the roof of the small tunnel in lieu of I-beams.

Concrete Mixers.—As large quantities of concrete were required in the construction of the north approach to the Union Station, rather elaborate plants were put in for mixing it. The first masonry built was in the train-shed section, hence the first mixing plant was erected on that section.

At a point near the intersection of G Street and the east terminal line a 5-ft. cubical mixer was placed, at a height of about 8 ft. above the ground. About 100 ft. distant a pit 16 ft. wide, 40 ft. long, and 11 ft. deep was provided. Two standard-gauge tracks were laid across this pit and for a distance of several hundred feet beyond. One track was used for handling and storing stone, the other for sand.

A cement house having a capacity of 2 500 bbl. was built near the pit. A narrow-gauge track, extending from the bottom of the pit to a point above the mixer, delivered sand, stone, and cement to the latter. The crushed stone and sand were delivered on the ground in steel hopper cars. The storage tracks were laid on a grade sufficient to permit the movement of cars by gravity.

The operation of this plant was as follows: The stone and sand cars being placed over the pit, the material was dumped from the cars into hoppers beneath the tracks. A specially designed car, holding, when full, sufficient material for one batch of concrete, was placed first under the stone hopper and the requisite quantity of stone allowed to run in. The car was then moved to the sand hopper, from which the necessary sand was obtained. The cement was then added. The proper proportions of ingredients were determined by metal strips placed on the sides of the car from actual measurements.

After receiving the proper quantities of sand, stone, and cement, the car was drawn up the incline by a cable to a point over a hopper above the mixer, and there dumped automatically and allowed to return to the pit. The material was then dropped from the hopper into the mixer. The necessary water was added by an automatic device which could be regulated according to the condition of the sand and stone.

The power for operating the mixer and for hauling the material

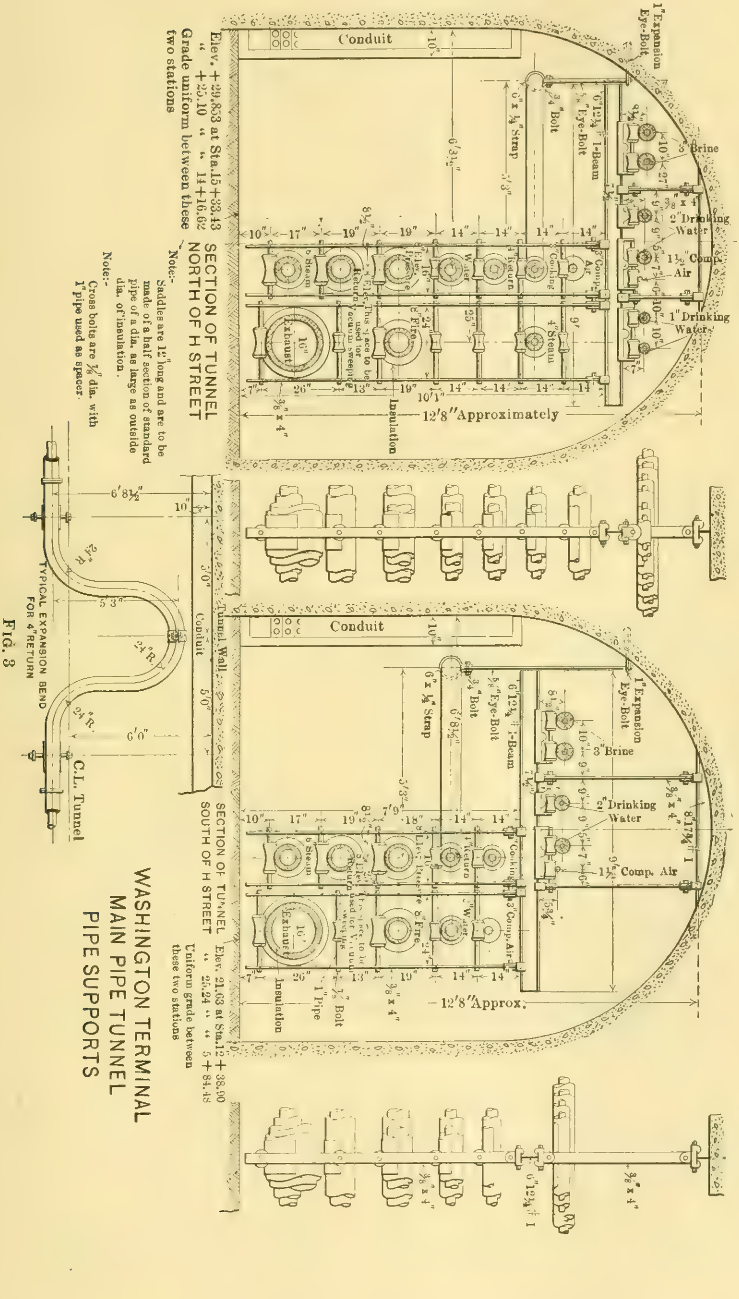

SECTION OF TUNNEL NORTH OF H STREET
Elev. +29.853 at Sta.15+33.43
" +25.10 " " 14+16.62
Grade uniform between these two stations
Note:- Saddles are 12" long and are to be made of a half section of standard pipe of a dia. as large as outside dia. of insulation.
Note:- Cross bolts are ⅞" dia. with 1" pipe used as spacer.
1" Expansion Eye-Bolt
Conduit
6'3½"
6" x ¼" Strap
¾" Bolt
⅝" Eye-Bolt
6" 12¼ # I-Beam
3" Brine
2" Drinking Water
1½" Comp. Air
1" Drinking Water
⅜" x 4"
6" Steam
6" Elev. Return
16" Exhaust
8" Fire
4" Return
Water
Cooking
4" Steam
3" Comp. Air
This space to be used for vacuum sweeping
Insulation
12'8" Approximately
10'1"
TYPICAL EXPANSION BEND FOR 4" RETURN
6'8½"
5'3"
6'0"
24" R.
C.L. Tunnel
Tunnel Wall
Conduit
SECTION OF TUNNEL SOUTH OF H STREET
Elev. 21.63 at Sta.12+38.90
" 25.24 " " 5+84.48
Uniform grade between these two stations
1" Expansion Eye-Bolt
6'8½"
8" 17¼# I
1" Pipe
⅞" Bolt
12'8" Approx.
6" 12¼ # I

FIG. 3

WASHINGTON TERMINAL
MAIN PIPE TUNNEL
PIPE SUPPORTS

up the incline was furnished by the same boiler. When the batch was properly mixed it was dumped into a bucket on a truck car, and conveyed by horses to the point where it was to be used. The actual time required to mix a batch after the material had been placed in the mixer was less than 2 min. The capacity of this plant when operated under normal conditions was about 350 cu. yd. per day of 10 hours.

PIPING IN H STREET PIPE TUNNEL

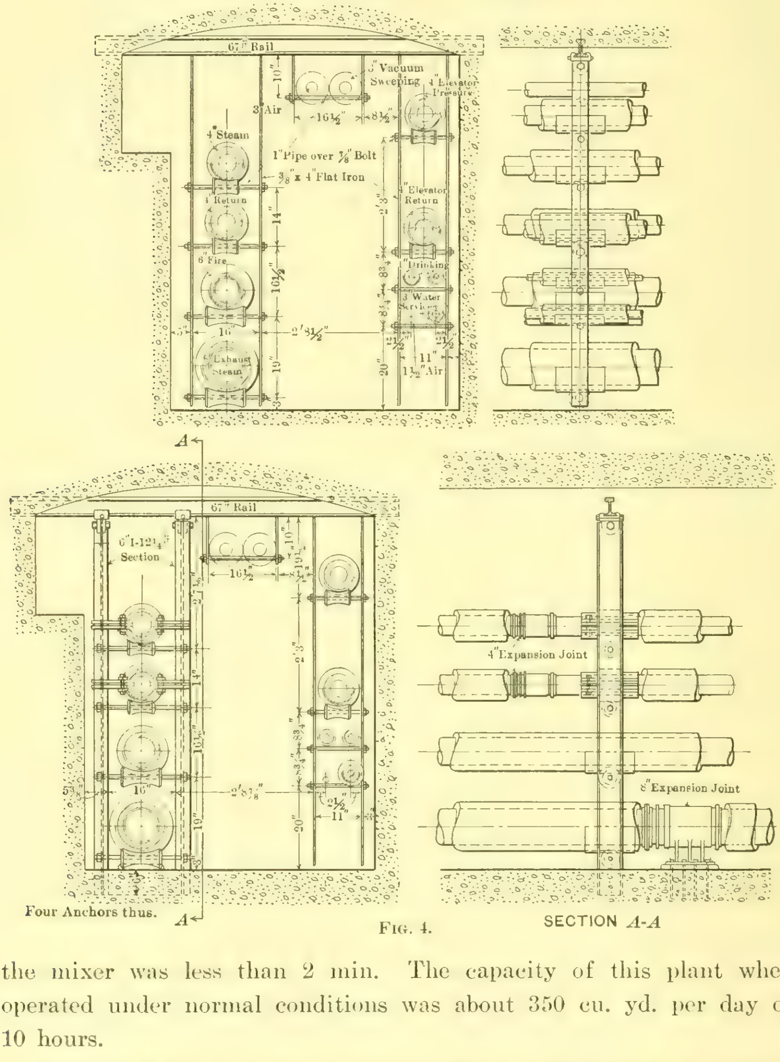


FIG. 4.

SECTION *A-A*

Another mixer of the same size and make, and set up and operated in the same manner, was located near the intersection of G Street and the west terminal wall, but, instead of a pit, as in the foregoing plant, there was a double-track trestle 220 ft. long, under which bins for stone and sand were provided. Beneath it, and extending its entire length, were two subways, each 6 ft. square, in which narrow-gauge tracks were laid for handling material. One line of bins was used for stone, the other for sand.

Near the trestle a cement house was constructed in such a manner as to permit the delivery of bags of cement to it by a chute. The cars for delivering material to the mixer were divided into two compartments, for sand and stone, respectively. In operating this plant, the cars were first passed under the sand-bins, from which the requisite quantity of sand was delivered to the sand compartment through apertures placed at regular intervals in the bottom of the bins. The cars were then pushed by hand to the extreme end of the subway and upon a transfer table, by which they were moved laterally to the line of track under the stone-bins. The necessary stone was then delivered to the second compartment. The cars were then moved to the outer end of the subway where there was a hopper for the delivery of cement. This hopper was constructed so as to hold the proper quantity of cement for a batch of concrete of given proportions. To facilitate the handling of cars under the material bins, the tracks were laid on a slight descending grade in the direction in which the cars were to be moved; in other words, there was a descending grade between the mixer and the transfer table, and a similar grade between the transfer table and the foot of the incline. The tracks on the incline between the material bins and the mixer were connected at the top of the incline by an automatic switch. Thus the empties were returned to the bins by one track and the loads were taken to the mixer by the other.

The capacity of such a plant depends on the speed at which the finished material can be removed. The output under normal conditions was about 400 cu. yd. per day of 10 hours. This plant had an advantage over the first one because the bins provided a place for the storage of material and permitted the prompt unloading and releasing of cars, which could not be done with the other plant, particularly when delays, on account of bad weather or for other reasons, prevented the operation of the mixer.

A Hains mixer was installed later at L Street for mixing the concrete for the abutments and retaining walls in that vicinity. The stone and sand were dumped into buckets from cars on temporary tracks over the streets and hoisted to the material platform at the top of the mixer by derricks. The quantity of masonry in this locality was too small to warrant the construction of an incline for the handling of raw materials. The capacity of this mixer depended entirely on the speed with which the material could be delivered to and taken from the plant. Under proper working conditions, with the materials located for expeditious handling, it had a capacity of about 400 cu. yd. per day.

Mixing plants similar to the one first described were erected at T Street and New York Avenue Bridges for mixing the concrete in these structures. Hains mixers were used for mixing the concrete for the station-building foundations, and for the masonry at the north end of the First Street Tunnel immediately in front of it.

Sub-surface Obstructions.—Considering the magnitude of the work and the radical changes in conditions, there were comparatively few sub-surface obstructions. Those of the greatest importance were a 9½-ft. trunk sewer in the bed of F Street, which formed part of the station site, and a 15 by 17½-ft. trunk sewer on the south side of Florida Avenue. To divert the F Street sewer required the construction of about 1 400 lin. ft. of new sewer across the plaza, at an expenditure of about $42 000.

Had Florida Avenue been depressed in accordance with the original plan, it would have exposed the top of the large sewer above mentioned. To avoid disturbing it, a slight increase in the rate of grade was made between K Street and Florida Avenue, and a reduction of about 6 in. in the depth of the bridge construction over this avenue. This plan left sufficient covering to permit the use of standard sidewalk construction. On account, however, of the proximity of the foundations of the south abutment on one side and the south line of pedestals on the other, it was necessary to reinforce the sides with concrete.

Other obstructions of minor importance, but causing considerable expense, were the 24-in. water main on K Street, which had to be depressed for a length of more than 1 100 ft., the greatest depth of trench being 15 ft. below the original street surface; the 24-in. gas main on Massachusetts Avenue, which had to be relocated for a distance of 4 200 ft., and the 12-in. main on G Street a distance of

2 500 ft. Similar but smaller obstructions were met on all streets and avenues where the grades were materially changed, and were either lowered or reconstructed.

Surface Obstructions.—On February 28th, 1903, when the Union Station Act was passed, the entire terminal area between Massachusetts Avenue and L Street was occupied by solid blocks of residences, stores, warehouses, and the main tracks of the Baltimore and Ohio Railroad; and to the south of the terminal area, on property to be utilized in part in forming the plaza and its approaches, were the main passenger and freight tracks, yards, and stations of the Baltimore and Ohio Railroad, together with some private property occupied as business places and residences.

Before the railroad property required in the building of the new station could be vacated, new coal and freight yards had to be constructed. Work was started on June 1st, 1903, 3 months after the passage of the Act, or as soon as plans could be prepared and property secured, and the old facilities were completely abandoned in August, 1904, 15 months after the work was started and about 9 months after work on the station was begun.

During this time the foundations for the east end of the station, involving about 20 000 cu. yd. of concrete and large quantities of excavation, were completed, and some preliminary work was done on the west end. The available space, however, was such that active work on the masonry at this point could not be started before the coal yards were completely abandoned. In October, 1904, the passenger traffic was thrown to the west side of the approach, thus removing the last obstruction to the progress of the work on the station building.

FOUNDATIONS.

The most serious problem to be dealt with on this work was foundations. Generally speaking, the foundation conditions were bad on nearly every part of the work, excepting portions of the coach and engine yard, and, with this exception, safe foundations were only secured after going to unusual depths. Material capable of sustaining the weight of the **V**-bridge and the coach yard and shop buildings was found at a depth of 3 or 4 ft. below sub-grade, and consisted of sand in the coach yard and dark red clay in the shop yard.

On the station site a bed of gravel was found at an elevation of about 10 ft. above tide, or from 12 to 15 ft. below the existing surface of the ground. The material excavated indicated that this locality was at one time a ravine and that a small stream flowed through near the north limit of the station site. Black loam, giving evidence of being decayed vegetable matter, was found immediately above the gravel bed. The 10 or 12 ft. of material overlying the original soil of the ravine was "made ground," and consisted of a fair quality of clay, but of poor sustaining power.

At H Street, about 800 ft. north of the station, no gravel was found, except a small quantity mixed with the clay, though at the west end of the bridge the excavations were carried approximately to tide, or a depth of about 25 ft. below the street surface. The material at this elevation was fine sand with a small quantity of blue clay of very unstable character. Although enormous quantities of water were encountered in putting down these excavations, an abutment having a total height of about 53 ft., built on this material, has never shown any signs of settlement.

The foundation conditions at the power-house stack and the method adopted to provide adequate support for it are described later. Clay containing sufficient gravel, however, to support the walls and pedestals of the power-house was found at an elevation of 22.5 ft. above tide. The material either above or below this elevation did not show a safe bearing capacity. As no indications of settlement have appeared up to the present time, it is presumed that the foundations are adequate.

The worst conditions on the entire work were met at K Street, where the original ground was about 48 ft. above tide. Tests showed nothing substantial at an elevation of 10 ft. below tide or 58 ft. below the surface. A careful examination of the material in this locality showed about 28 ft. of yellow clay containing thin layers of gravel, not sufficient, however, to provide suitable foundations for heavy construction. Beneath this, to a depth of about 15 ft., there was blue clay of about the consistency of putty. Under this, to an uncertain depth, was found a sandy material, containing sufficient clay to endanger its stability. Test piles were then driven, but failed to locate material showing proper sustaining qualities until a depth of 25 ft. below tide was reached, nearly 75 ft. below the original surface. When assured of these conditions by the above tests, it was decided to put in pile foundations for approximately the west half of both abutments. At L Street some blue clay was encountered, but not enough to require the use of piles.

At M Street and Florida Avenue, where the street surfaces were lowered 15 or 16 ft., a fair quality of sand was encountered, so that the foundation conditions at these points might be considered normal. A ravine, about 20 ft. in depth below the established grade, ran across what is now the west end of the New York Avenue Bridge. Several years before the terminal improvements were started, this ravine was converted into a city dump and filled to grade with miscellaneous material, largely rubbish and ashes.

To secure suitable material to support the bridge, it was necessary to go to a depth of from 25 to 36 ft. The latter depth was reached at the east abutment, which is built over a trunk sewer, the top of which is about 25 ft. below the surface of the ground. To protect the sewer, an arch was formed in the abutment, the masonry on either side being carried down to a point at or below the bottom of the cradle. The west abutment and the intermediate piers were carried to a depth of about 25 ft. below the roadbed, at which elevation sand of fair bearing capacity was found.

At T Street Bridge reasonably good foundation conditions prevailed, except at the west end, where the same ravine was found and where the same sewer was in the way of a pier. Foundations of normal depth were found at the sites of all the buildings in the engine and coach yards, including the pivot piers of the turn-tables at the shops. The only troublesome foundations in this vicinity were those of the locomotive inspection pits, which fell in a swampy ravine requiring an additional depth of about 10 ft. of excavation and masonry.

BRIDGES.

Within the city limits all streets and avenues north of the station were depressed so as to permit them to be taken under the railroad tracks. As the grade established for the tracks from K Street northward coincided very closely with the original surface of the ground, it was necessary to lower K, L, and M Streets and Florida Avenue a maximum of from 12 to 16 ft. at their points of greatest depression. The grade of the low-level tracks required the depression of H Street a maximum of about 11 ft. These depressions were carried a distance of from 300 to 500 ft. beyond the terminal lines, in order to avoid excessive grades. Second Street, E., was lowered to conform to the new grades of intersecting streets from G Street to its intersection with Delaware Avenue near L Street, and from N Street to Florida Avenue. The east 40 ft. of Delaware Avenue, between L and M Streets, was also depressed to coincide with the new elevations of those streets.

In order to reduce to a minimum the depression of the various streets and avenues, it was decided to adopt a shallow floor system. This could only be obtained by the use of short spans. A width of 80 ft. at right angles to the axis of the street was adopted for all streets and avenues to be bridged. As a double-track street-car line occupied H Street, and one was in prospect at Florida Avenue, the Commissioners agreed to permit the use of three-span structures in all cases. The center bay spanning the street-car tracks was made 25 ft. in length, from center to center of columns, and the side-bays, 27 ft. 6 in. between the centers of the columns and the faces of the abutments. The center spans and inner ends of the side-spans were supported on columns and box girders, the outer ends of the side-spans on abutment walls defining the new street limits. As a water-tight structure was desired, and the track arrangement precluded the use of anything but deck construction, I-beams encased in concrete were used.

In all bridges, except over Florida Avenue, 24-in., 80-lb., I-beams, spaced at intervals of about 18 in., were used. These beams were embedded in concrete, the bottom of which extended 2 in. below the bottom flanges, the top being flush with the tops of the beams. Upon the surface thus formed a $\frac{3}{4}$-in. layer of a Texas oil residuum, known commercially as Hydrolene B, was used, the top of which was covered with heavy burlap. As a protection to the water-proofing, a layer of reinforced concrete, from 5 to 6 in. thick, was used. The track superstructure consisted of 6 in. of ballast, 7-in. ties, and $5\frac{3}{16}$-in. rails, the entire depth of construction from top of rail to bridge seat being 4 ft. The construction of the Florida Avenue Bridge was similar, but the I-beams were 20-in., 80-lb., and spaced at intervals of about 12 in. from center to center.

The bridges at Florida Avenue and M Street each carry ten tracks, and are about 135 ft. wide, divided into two sections accommodating five tracks each. There is a space in the center, 4 ft. wide, for prismatic lights for lighting the subways beneath. The L Street Bridge is about 220 ft. wide, and carries, in addition to the ten tracks, switching leads for the east and west sides of the train yard. This bridge has in the center an opening, about 10 ft. wide, covered with Clinton wire cloth, for lighting and ventilating the subway. The bridge at K Street is about 450 ft. wide, and has a 10-ft. opening approximately in the center, with two spaces, about 3 ft. wide, containing prismatic lights on either side.

The construction of H Street Bridge was more complicated. The platforms of the train yard extended across this structure and necessitated a style of construction which would raise the tops of the platforms 8 in. above the top of rails of the adjacent tracks. This structure is about 790 ft. wide, and contains 18 platforms, one-half of which are of prismatic light construction, the other of reinforced concrete. It is divided into two sections, one about 496 ft. long, carrying the high-level tracks, the other nearly 300 ft. long, carrying the low-level tracks. The difference in elevation between the high- and low-level sections at this point is about 8 ft. There is a vertical opening for ventilation between the bottom flange of the fascia girder of the high-level section and the top flange of the fascia girder of the low-level section. This opening is protected by Clinton wire cloth.

In addition to the bridges for carrying the tracks over the various streets and avenues, two bridges were erected for carrying streets and avenues over the railroad tracks. One is a steel truss bridge consisting of four spans, aggregating 712 ft. in length, with asphalt roadway and concrete sidewalks, erected on the south half of T Street for carrying the street traffic over the Baltimore and Ohio Railroad freight storage yard, the Metropolitan Branch tracks, the north end of the coach yard, and the Y-tracks between the Metropolitan and Washington Branches. The other is a steel plate-girder and I-beam bridge, encased in concrete, on the line of New York Avenue, spanning the main tracks of the Washington and Metropolitan Branches of the Baltimore and Ohio Railroad, the Magruder Branch of the Philadelphia, Baltimore and Washington Railroad and the south end of the coach yard; its total length on its center line is about 410 ft.

Water-proofing.—In order to keep the various subways as dry as practicable, the backs of all abutments, as well as other portions of the terminal construction, were water-proofed with the material used in water-proofing the decks of the bridges. This material, up to the present time, seems to show satisfactory results, where used for level surfaces when properly protected. Its use for vertical walls, however, cannot be recommended, as it does not possess the adhesive qualities necessary for this purpose. It was also found that, on exposure to the hot summer sun, it had a tendency to separate at the offsets and drop down. It is also believed, from present appearances, that the settlement of the fill back of the abutments has in some instances torn the water-proofing loose, leaving the walls exposed.

On account of the failure of Hydrolene as a water-proofing substance on the backs of the abutments of bridges on the terminal, coal-tar was substituted for these parts of the New York Avenue and T Street Bridges. It was applied with a mop, two or three applications being given; at the present time it is giving very satisfactory results.

Outside of these cases, the only other water-proofing north of the station was in the pipe tunnel under the north sidewalk of H Street, leading to the express building. Soon after this work was completed, water began entering this tunnel through the south wall, and, as the bottom of the tunnel at the west end was 3 or 4 ft. below the normal ground-water line, a contract was made with the E. J. Winslow Company, of Chicago, to apply Winslow's hydrolithic compound. After this material had been applied, to the proper height, the water seemed to rise, entering the tunnel above the normal line. An investigation disclosed a broken water pipe in the street near the south wall of the tunnel. After the pipe was repaired the tunnel became practically dry, indicating that the greater part of the trouble was due to that source. In order to take care of any water which might find its way into this subway in the future, a sump was constructed at the lowest point, where a small electric pump was placed.

Main Power-Plant.

The main power-plant is on the west side of and opposite the outer end of the train yard, at what was formerly the intersection of I and First Streets, N. E., about 1 200 ft. north of the station. It consists of a masonry and steel structure, 78 ft. wide and 234 ft. long, with an extension, 30 ft. wide and 150 ft. long, at the south end, used as an office building, storeroom, and repair shop.

The west side of this structure is carried down to the street level, and the north, east, and south sides are supported on concrete retaining walls carried up to the track level.

The concrete retaining walls were required to withstand the pressure of the fill deposited in forming the roadbed, which is about 20 ft. above the street level on the west side. On account of unstable material, the foundations were carried 12½ ft. below the basement floor level. The rail grade in the yard practically coincides with the floor level in the boiler-room. The engine-room floor is about 8 ft. below the boiler-room, and the basement is about 2 ft. below the average street level on the west side.

To make the basement story of the power-house and office extension harmonize with the retaining walls north and south of it, the west wall of the building was built of stone laid in courses corresponding in thickness to those used in the retaining walls. Above the height of the retaining walls, the building walls are of brick with Indiana limestone trimmings. The cornice and eaves are of galvanized iron painted to conform to the color of the stone trimmings.

The power-house, except a space at the south end 35 ft. long and of the width of the building, is divided longitudinally by a wall, about 17 in. thick, extending from the basement to the roof, providing a 40-ft. boiler-room on the east side and a 36-ft. engine-room on the west side. The space at the south end is used in connection with the refrigeration plant and water tanks. Space is also set aside for an ice-making plant, which will be provided at some future time.

The basement under the engine-room is 11 ft. high and under the boiler-room 20 ft. The engine-room has a clear height of about 30 ft. to the under side of the roof trusses, providing space for the operation of a traveling crane, the runway rail of which is 23 ft. above the engine-room floor. As the economizers, and coal and ashes bunkers are above the boiler settings, this portion of the building was constructed so as to provide head-room of about 44 ft. to the under side of the roof trusses.

The main roof is of book tile, concrete, and red vitrified Spanish tile; the flat roof over the engine-room is covered with Ehret's slag roofing laid on reinforced concrete roof construction. The building is amply lighted on all sides, each wall panel having a 10 by 18½-ft. window, the sashes in which are in hinged sections with a Pond sash-operating device. Clerestory windows furnish light and ventilation for the extreme upper portion of the building.

In this plant provision has been made for future growth. The boiler-room will accommodate ten boiler units, though only seven are considered necessary at present. In the engine-room provision is made for six 500-kw. turbo-generators, though four are capable of supplying all needed power at present.

A consideration of the power requirements at the station, in the yard, and at the shops, showed the necessity of a general plant to furnish steam heat for the depot, express building, signal towers, and train yard; electricity for light and power over the entire passenger terminal occupation; compressed air for the operation of switches and signals, testing air brakes on trains at the station, and providing the necessary air cushion in elevator pressure tanks; hydraulic pressure for operating passenger elevators, baggage lifts, and fire service; and refrigeration for the drinking-water system and refrigerators in the restaurant, kitchen, and other service-rooms.

Power-House Stack.—The chimney for the power-house, except the foundation, was built by the Alphons Custodis Chimney Construction Company, of New York, and contains no unusual features. It is 275 ft. high above the foundation, and extends about 200 ft. above the highest point of the roof of the power-house. The base, octagonal in form and 19 ft. high, is laid up in plain hard red brick, the minimum thickness of wall being 40 in. Above this point it is of the usual perforated radial blocks, ranging in length from 4 to 10⅝ in. The blocks in the lower portion of the work were obtained from Birmingham, Ala., those in the upper portion from Washington, Pa. The work was all laid in a mortar composed of 1 part Portland cement, 2 parts lime, and 4 parts sand.

It has an inside diameter of 16 ft. 8 in. at the base and 11 ft. at the top, the thickness of wall varying from 30 in. at the base to 7⅛ in. at the top. Starting at a point 16 ft. above the octagonal base, the variations in thickness occur at intervals of 20 ft. throughout the remainder of the height, dividing the stack above this point into twelve sections, which, with the 19-ft. base and 16-ft. section of radial blocks above noted, constitute the fourteen sections into which the total height is divided.

The chimney, to a height of 200 ft., is lined with fire-brick 4 in.

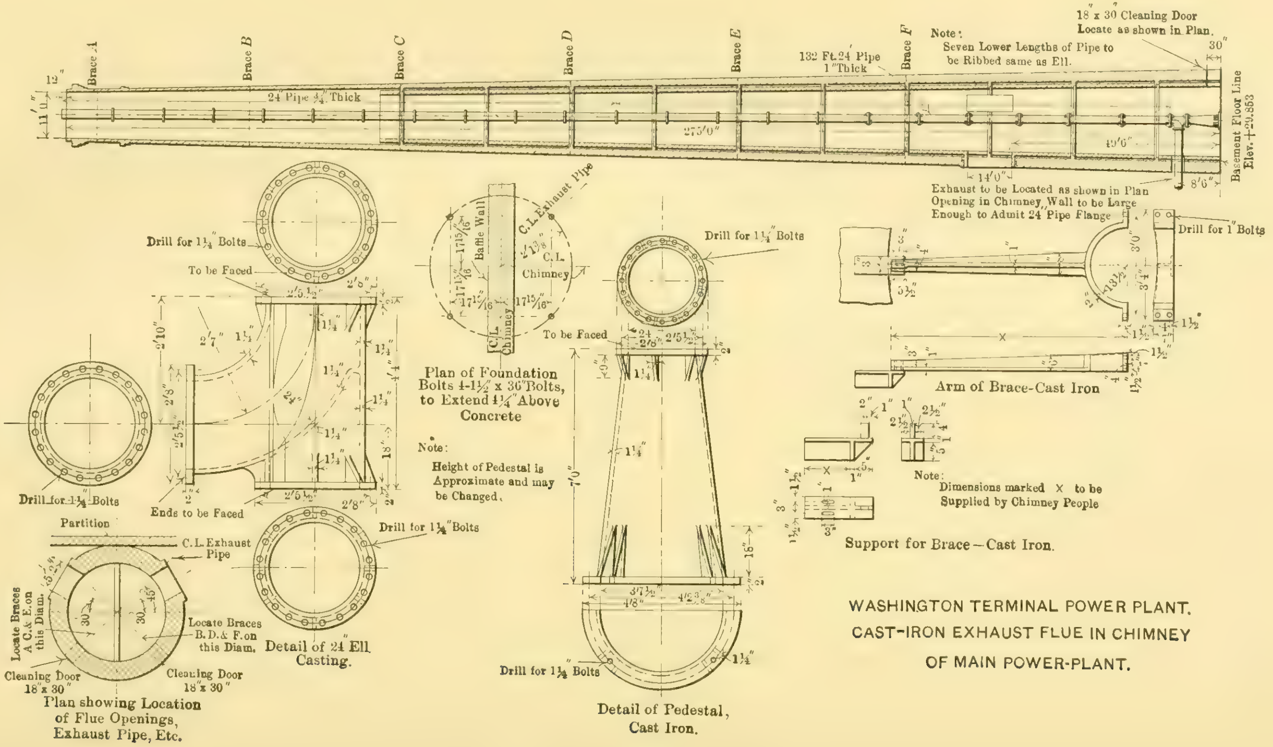

Brace A
Brace B
Brace C
Brace D
Brace E
Brace F
12"
11' 0"
24" Pipe ¾" Thick
275' 0"
132 Ft. 24" Pipe 1" Thick
Note: Seven Lower Lengths of Pipe to be Ribbed same as Ell.
18" x 30" Cleaning Door Locate as shown in Plan.
30"
49' 6"
14' 0"
8' 6"
Basement Floor Line Elev. +29.853
Exhaust to be Located as shown in Plan Opening in Chimney Wall to be Large Enough to Admit 24" Pipe Flange
Drill for 1" Bolts
Drill for 1¼" Bolts
To be Faced
Ends to be Faced
2' 10"
2' 7"
2' 8"
2' 5½"
Partition
C.L. Exhaust Pipe
Locate Braces A C.& E. on this Diam.
Locate Braces B. D. & F. on this Diam.
Cleaning Door 18" x 30"
Cleaning Door 18" x 30"
Plan showing Location of Flue Openings, Exhaust Pipe, Etc.
Detail of 24" Ell Casting.
Baffle Wall
C.L. Exhaust Pipe
C.L. Chimney
17 15/16"
Plan of Foundation Bolts 4-1½" x 36" Bolts, to Extend 4¼" Above Concrete
Note: Height of Pedestal is Approximate and may be Changed.
7' 0"
18"
4' 8"
3' 7½"
Detail of Pedestal, Cast Iron.
Arm of Brace-Cast Iron
Note: Dimensions marked X to be Supplied by Chimney People
Support for Brace—Cast Iron.

FIG. 5.

WASHINGTON TERMINAL POWER PLANT.
CAST-IRON EXHAUST FLUE IN CHIMNEY
OF MAIN POWER-PLANT.

thick, and the lining is divided into sections corresponding to those in the outer wall. Each section of the lining is supported on a corbel or offset formed in the outside brickwork at the section points. There is a 2-in. air space between the 4-in. lining and the outer wall. This sectional construction is the usual Custodis arrangement, the result being greater stability in the chimney and greater ease in making renewals or repairs, as only one section need be disturbed at a time.

The two flue openings, each 5 ft. 2 in. wide and 14 ft. high, are 49 ft. 6 in. above the basement floor, and separated by a 12-in. baffle-wall of brick 21 ft. high, supported on an I-beam platform 46 ft. above the foundation.

The point of special interest in this chimney is the exhaust riser in the center, the top of which extends a short distance above the top of the brickwork. It is constructed of 12-ft. lengths of 24-in. cast-iron pipe with flanged ends and bolted joints. There are twenty-two 12-ft. sections in the pipe column proper, the lower half of which has 1-in. walls, the upper half ¾-in. walls. This pipe column is supported on a 7-ft. pedestal having an outside diameter of 4 ft. 8 in. at the base and the same diameter as the pipe at the top, to which is bolted the base elbow, 4 ft. 4 in. long. The pedestal is bolted to the foundation by four 2-in. foundation bolts. The lower seven sections of pipe are reinforced by ribbed flanges similar to the reinforcement of the pedestal and base elbow. For the upper portion of the column there are six sets of cast-iron braces or stays at intervals of from 35 to 40 ft., the lowest one being about 75 ft. above the foundation. Below this point the pipe is sufficiently stayed by the baffle-wall between the flue openings. The cast-iron braces or stays have semicircular straps or bands at one end for bolting to the column, two being used at each of the six points. The outer ends are attached to brackets built in the wall, each pair of braces alternating at right angles with the pair above or below.

The foundation was included in the power-house contract. Before deciding on the style of foundation, test holes were bored to a depth of from 60 to 65 ft. below the original surface of the ground, for the purpose of obtaining some idea of the character of the soil. At a depth of about 15 ft. a great deal of water was encountered, requiring a casing to be driven as the hole was formed. For the first 15 ft. the soil was composed of a mixture of clay and gravel in irregular layers and pockets. Below this elevation the material was a mixture of very fine sand and blue clay, of a very soapy nature.

In order to make a more thorough examination, a test hole 8 ft. square was started, the sides being shored in a most careful manner. There was no difficulty in excavating the first 16 ft., but, before a depth of 30 ft. was reached, the water and sand were forcing their way into the hole faster than one pump and several men could remove it. On account of the danger of disturbing other foundations by this flow of water and sand, and as the results were similar to those where holes were bored, this test was also abandoned and the hole filled.

The original plan contemplated the use of concrete piles to be put in by the Simplex method. Equipment for this purpose was brought to the site and several test piles were driven. On account of the large quantity of sand in the soil, there was considerable difficulty in driving the tube to the required depth, and, when driven, the contractor had greater difficulty in withdrawing it. It was necessary to begin to remove the tube as soon as the placing of concrete was started, but water and sand forced their way into its lower portion with such speed as to prevent filling it with concrete. In the two or three test piles put down the quantity of concrete used was 15 or 20% less than required, indicating that a portion of the space was filled with water and sand, and as there was no way of determining definitely where it might be located, piles of this kind had to be abandoned.

Owing to the presence of so much sand in the soil, some doubt was expressed as to the possibility of driving a sufficient number of wooden piles to carry the load. After due consideration, wooden piles seemed to be the last resort, and arrangements were made to drive them at intervals of about 3 ft. from center to center. The work was started by driving from the circumference toward the center. This plan was adopted in the hope of getting the best results around the outer edge where the greatest load would result from wind pressure. The displacement of soil was not so great as anticipated, and the piles in place were not disturbed by driving adjacent ones. There was great difficulty, however, in driving them to a safe depth, a large number breaking in the driving. This was especially true in the south half of the foundation. In all, however, 191 pine piles were driven to an average depth of about 25 ft. below the cut-off line. As the load on the foundation, including wind pressure, is about 5 000 tons, each pile under the severest strain must sustain more than 25 tons.

As a protection against lightning, the stack has a lightning rod of ½-in. stranded copper cable terminating at the base of the stack in a coil in the earth and above in a loop extending around the top, to which six retort-graphite points, 5 in. long and 1 in. in diameter, are attached with ¾-in. galvanized-iron pipe and suitable brass sleeves. The connection between the copper cable and the graphite point is made by drilling a ½-in. hole in the end of each point to a depth of 2 in., the copper being held to the graphite by a suitable set-screw. The cable is secured to the side of the chimney by braces and clamps.

Boilers, Super-heaters, and Stokers.—The Babcock and Wilcox Company, of New York, furnished and erected seven semi-marine water-tube boilers, seven super-heaters, and seven chain-grate stokers. The boilers are set singly and supported on concrete-encased girders and beams forming the longitudinal and cross-members of the boiler-room floor system. Each boiler has a heating surface of 4 220 sq. ft. and a rating of 420 h.p. The settings are fashioned after the Dutch oven-furnace construction, with combustion chambers well within them, the tops of which extend about 22 ft. above the boiler-room floor. The tube sections in each unit are inclined at an angle of 15° with the horizontal, and are 14 ft. long. The heating surface consists of 4-in. tubes, arranged in 20 sections, 13 tubes high. The iron casings around the fire-box are bolted to the structural-steel framing forming the sections for each unit, and to the casing plates are fastened the non-conducting linings consisting of ¼-in. asbestos mill-boards, which in turn are protected by light fire-tile.

There is a steam and water drum, 42 in. in diameter and 13 ft. long, of open-hearth steel ½ in. thick, above the front end of each boiler at right angles to the tube sections. The longitudinal seams of the drum are butted and strapped, both inside and out, and are secured by four rows of rivets, two of which extend through both straps and shell plates, the other two extending only through the inside strap and shell. The drum heads are of $\frac{9}{16}$-in. steel plates spherically bumped, the radius of the bump being equal to the diameter of the drum. Each head has an 11 by 15-in. manhole flanged and properly reinforced to provide for gasket not less than 1 in. wide. Each drum is connected with each of the lower front serpentine headers by 4-in.

vertical tubes, and with the rear headers by horizontal tubes of the same size, thus affording twenty independent inlet and outlet connections for steam and water. All attachments for steam and water valves and other fittings are of wrought-steel pads or nozzles securely riveted to the drums.

A mud-drum, consisting of a 6-in., square, forged-steel box, is connected to the lower ends of the front tube headers, for blowing down and draining the system. All pressure parts are of open-hearth steel plate and seamless tubes. All tubes are 4 in. in diameter and No. 9 B.w.g. in thickness, expanded at the ends into wrought-steel headers. Access to the front and rear ends of the boiler tubes is provided by rolling shutter doors.

Each boiler has two 4-in., Coale, muffler safety-valves set to blow at 200 lb., one Ashcroft, 12-in., brass-rimmed gauge graduated to 300 lb., one Babcock and Wilcox, water column, three try-cocks arranged for operating from the fire-room floor, one 2½-in. stop- and check-valve, two 2½-in., Babcock and Wilcox, bottom-blow valves, together with wrenches, tube-cleaners, steam-hose, and cleaning pipe for removing soot from the exterior of the tubes. All tube sections and steam- and water-drums were designed to stand a test under water pressure of 300 lb. per sq. in. with a working pressure of 200 lb.

Each boiler unit is fitted with a Babcock and Wilcox superheater above the incline tube sections, to the rear of the smoke uptake. It is composed of 2-in., seamless, U-shaped tubes expanded at the ends into wrought-steel box headers. The steam is piped from the steam-drum to the lower superheater header at the rear with delivery connection on the other header. Each superheater is composed of 76 tubes, presenting a heating surface of 695 sq. ft., and designed to raise the temperature of steam 100° Fahr. above that of saturation. There is a safety-valve for each heater on the discharge side, set to blow below the safety-valves on the boilers. The main steam outlet is 6 in. in diameter. The regulation of superheat is facilitated by dampers located so as to control the passage of gases, by shunting part of them below the heater when necessary. The dampers are operated by drum and wire rope, the apparatus being controlled from the outside.

Each boiler has a Babcock and Wilcox, chain-grate stoker, 8½ ft. wide and 10 ft. long, operated by a line shaft under the boiler-room floor, to which the stokers are connected by detachable gear. The power is furnished by two vertical, slide-valve engines in the basement under the boiler-room floor. The line shaft can be operated by one or both engines by the use of clutches. Each grate has an area of 85 sq. ft., or approximately 1 sq. ft. of grate area to 50 sq. ft. of boiler heating surface. Coal is delivered to the stokers by downspouts from the storage bunkers in the upper portion of the boiler-room. The bunkers are of reinforced concrete, there being a continuous line, except opposite the chimney, the entire length of the building. Each bunker is 5½ by 10 by 14 ft., and the entire layout has a capacity of 600 tons. In the section opposite the chimney, occupying a space 32 ft. long, are located the ashes bunkers, the bottoms of which slope outward instead of inward as do the coal bunkers. There are two delivery spouts for chuting the ashes into cars on the track outside the building.

Economizers.—The Green Fuel Economizer Company, of Matteawan, N. Y., furnished and put in seven improved patent fuel economizers, containing 8 084 sq. ft. of heating surface, one over each boiler unit, through which the furnace gases pass in reaching the main chimney breeching.

Each economizer consists of sixteen sections of 4-in. tubes, each section composed of six tubes 9 ft. long, connected at top and bottom by headers, in which the ends of the tubes are turned and pressed by hydraulic machinery. The top headers are planed and fitted to insure air-tight joints, and have hand-hole lids opposite the vertical tubes to facilitate cleaning and making repairs. Outlet and inlet branches have access lids for cleaning the bottom headers.

Each unit has a heating surface of 1 152 sq. ft., a trifle more than one-fourth that of the boiler unit, and was constructed to stand a test of 350 lb. per sq. in. at the works, or 200 lb. per sq. in. hydraulic pressure after erection at the plant. Each economizer has a 2-in. safety-valve, the necessary cast-iron soot-pit frames, air-tight doors, and side-dampers. Each unit has improved scraper gears, the line shafts for operating them being attached to the edge of the coal bunkers. They are divided into two groups, respectively, north and south of the stack. Each group is operated by a 10-h.p. motor. The north group at present contains four units, the south group three. Each line shaft is designed to take care of five units eventually.

The economizer units are supported on a steel framework over the boiler units, and are enclosed with steel plates lined with fire-brick, instead of the usual brick enclosures. The rear end of the economizer connects directly with the main breeching; the front end connects directly with the uptake from the boiler which leaves from the front side of the boiler setting.

The breeching connecting the boilers with the stack is divided into two sections, one taking care of the boilers on the north side of the stack, the other those on the south. It consists of a horizontal duct of $\frac{3}{16}$-in. steel plates, 4 ft. 9 in. by 9 ft. 9 in. in section, lined with $2\frac{1}{4}$-in. magnesia blocks coated with $\frac{1}{2}$ in. of retort cement furnished by The Philip Carey Company, of Cincinnati, Ohio. The Patterson Manufacturing Company, of Baltimore, Md., placed in each section of the breeching a hydraulic damper regulator, which is controlled by the steam pressure.

Feed-Water Heaters.—The Harrison Safety Boiler Works furnished and erected two No. 334, Cochrane, special, feed-water heaters and receivers, including the Sorge-Cochrane system of water purification. Each heater is 139 in. wide, 78 in. deep from front to back, and 105 in. high. In each heater there are 20 perforated trays, 12 in. wide and 36 in. long, and a filter bed, 36 in. wide and 72 in. long. The exhaust inlet and outlet are 14 in. in diameter, the cold water supply 4 in., the pump suction 8 in., the waste or overflow 4 in., and the gravity returns 8 in. This apparatus is especially designed and adapted for use with any steam heating or drying system, under vacuum or back-pressure. In addition to performing the regular functions of an open or direct-contact feed-water heater, it provides for the reception and heating of the condensation from the heating system. The supply of cold water, to supplement the exhaust condensed in the heater and the condensation from the heating system, is regulated automatically. The drip from the oil separator and the overflow from the heater are carried to waste through a steam-trap forming part of the heater.

All parts exposed to water or escaping gases are of cast iron, brass, and copper. The oil separator, attached to the shell and forming part of each heater, is a most efficient device for removing cylinder oil from exhaust steam, and is designed and proportioned for a normal steam velocity of 6 000 ft. per min. through engine ports and steam pipes. The perforated trays are in the upper part of the heater, and are interchangeable and removable. They are inclined in alternate directions, and the edges over which the water flows are serrated for breaking it up. They are secured in place by cast-iron guides bolted to the shell of the heater in such a way as to prevent them from being dislodged by the pulsations of the exhaust. Each set of trays is in the steam space, with passages between the trays and tray supports giving a greater area for steam than the inlet opening, thus bringing the steam into contact with the water as it flows from tray to tray. After passing through the regulating valve, the cold water is conveyed by pipe to a box or trough extending across the trays, from which it falls through openings to the upper trays, across which it flows, dropping to the one below, and so on, until it reaches the bottom one, from which it drops into the settling chamber in the lower part of the heater. The flow of cold water is regulated by a balanced valve controlled by a ventilated copper float in the heater. Any change in the level of the water raises or lowers the float, thus opening or closing the valve and supplying water in proportion to the quantity taken from the heater by the boiler-feed pump, and preventing waste by overflow.

A skimmer, just above the working level of the water and extending the width of the heater, removes the impurities which rise to the surface of the water. To take care of additional refuse matter, all Cochrane heaters have perforated plates, about 4 in. above the bottom of the heater, upon which is placed the filtering material The outlet to the pump is covered with a hood, extending to the perforated plates, open at the bottom and vented at the top by a pipe to prevent air-logging and consequent interference with the pump suction. It also prevents the siphoning of water from the heater, and maintains a seal for keeping the floating impurities from the pump suction. The hood insures the passage of all water through the filter.

The gravity returns are brought into the heater by a specially designed trough which forms a water seal for the return pipe and prevents the escape of steam from the heater into the heating system. Thus the water of condensation is brought into contact with exhaust steam in the heater, which insures the same temperature as the water in the pool. Returns from the vacuum pumps are taken into the heater through the cold-water pipe by special connection between the heater and the regulating valve.

These heaters are guaranteed to separate the cylinder oil (carried in the exhaust steam) from the water, making it suitable for boiler feed and other purposes; and, if given a sufficient supply of exhaust steam, will deliver feed-water at a temperature within from 2 to 5° of the temperature of the steam entering the heater.

They will give all purification which can be obtained by heating water to the temperature of exhaust steam, by providing large filtering and settling surfaces and utilizing the steam condensed in heating the water, and will provide for the reception and heating of water condensed in the heating system, the return being made by gravity or pumped into the heater. They will control the cold-water supply automatically, so that no cold water will be introduced into the heater until the returns from the heating system are found insufficient to meet the demand, and the steam leaving the heater will be freer from water than when leaving the engines.

Each heater is designed to raise the temperature of 60 000 lb. of water per hour from 60° to 210° Fahr. The main source of steam supply is the exhaust main serving the air compressors, elevator pumps, and auxiliary engines in the plant.

Pumps.—The Epping-Carpenter Company, of Pittsburg, Pa., furnished and erected, on foundations provided by the Terminal Company, two 16 by 10 by 16-in., duplex, outside, end-packed, pressure-pattern, boiler-feed pumps, two 12 by 8 by 16-in., duplex, outside, end-packed, pressure-pattern, boiler-feed pumps for building service, and two 18 by 10 by 12-in., underwriter fire-pumps by the George F. Blake Manufacturing Company. In all these pumps the water-cylinder stuffing-boxes and glands are bronze-lined. Each pump has a 2-qt. Richardson oil pump.

The boiler-feed pumps have 8-in. suction and 6-in. delivery nozzles, for water connections with 3-in. steam supply and 4-in. exhaust, and are capable of delivering 600 gal. of water per min. at a piston speed of 75 ft. and 300 lb. pressure. The building-service pumps have 6-in. suction and 5-in. delivery nozzles, for water connections with 2½-in. steam supply and 3-in. exhaust, and are each capable of furnishing 350 gal. per min. at a piston speed of 67 ft. and 300 lb. pressure. The fire-pumps have 12-in. suction and 8-in. discharge nozzles, for water connections with 4-in. steam supply and 5-in. exhaust, and are each capable of delivering 1 000 gal. per min.

Pumping Engines.—The Nordberg Manufacturing Company, of

Milwaukee, Wis., furnished and erected two horizontal, heavy-duty, cross-compound, non-condensing, Nordberg, poppet-valve, pumping engines, with cylinders 12 by 21½ in. and plungers 5¾ in. in diameter, having a common stroke of 24 in. When running at a piston speed of 300 ft. per min., or 75 revolutions, under a steam pressure of 150 lb. at the throttle, with 100° Fahr. superheated steam, these engines will pump 750 gal. per min. against a pressure of 300 lb., with a suction pressure of 40 lb.

Under the foregoing conditions, the steam consumption will not exceed 1 000 lb. of dry steam containing 100° Fahr. superheat for every 85 000 000 ft-lb. of work done; and, when the steam contains 50° Fahr. superheat, the steam consumption will not exceed 1 000 lb. for every 75 000 000 ft-lb.

The pumps consist of two cylindrical chambers, containing seats for delivery and suction valves, which are located one above the other. There is one pressure air chamber above each side of the pump. Each pump rests on, and is bolted to, a cast-iron suction base.

The two chambers are connected firmly by removable distance-rods located in a plane passing through the center line of the engine, and by the delivery and suction immediately above and below the same. The chamber nearest the steam cylinder is connected to it by similar rods, making the engine self-contained. The stuffing-boxes and plunger-rods are lined with brass, and the valve faces with leather. The valve seat has a central spindle which passes through and guides the valve, the lift of which is controlled by a spring, and has an area of 40 sq. in. for both suction and discharge.

The frames are of the heavy-duty type, and cast in one piece. The flange (on which the cylinder head is centered) and the slides were bored at one setting, insuring perfect alignment. The base of the frame extends the full length of the frame, and has up-turned edges for catching oil. The steam cylinders are jacketed all over, including the heads, and are cast with double walls to provide a steam jacket. The cylinders are fitted with Nordberg, poppet-valve gear, each cylinder having four equilibrium poppet-valves, the steam inlet-valves being on top and the exhaust at the bottom of the cylinder.

Coal and Ashes Handling Apparatus.—The C. W. Hunt Company, of New York, furnished and erected a Hunt coal and ashes handling equipment, comprising a conveyor consisting of buckets, chains, tracks and supporting stands, curves, take-up, chain-guard, and dumpers; a conveyor driver having a two-cylinder steam engine, geared for 150 lb. steam pressure; and two steam-driven, direct-connected coal crackers, with two cross-belt conveyors for carrying coal from the crackers to the Hunt conveyor.

The coal is delivered at the plant in regular, drop-bottom, coal cars, from which it is dumped into a hopper having a capacity of about 50 tons, located under the track on the east side of the building. From this hopper the coal passes through the crackers and thence by belt conveyors to the bucket conveyor, to be stored in the bunkers in the upper part of the boiler-room.

The coal is delivered to the bucket conveyor by a rotary filler, which insures a uniform and even supply. In delivering the coal to the bunkers, the conveyors have a lift of 62 ft., a speed of about 40 ft. per min., and a capacity of about 60 tons per hour.

The dumpers are placed at intervals along the upper run of the conveyor, and are easily thrown in and out of gear by the operator. The ashes are delivered to the ashes bunkers by the same conveyor. To permit this being done, there are reinforced concrete pockets under each chain grate, in which the ashes are collected. At the bottom of these hoppers there are reinforced concrete spouts or chutes through which the ashes are chuted to the conveyor and thence carried to the ashes bunkers. The ashes are taken from the bunkers by chutes leading through the east wall of the building, from which they are delivered to cars on the siding used for the delivery of coal, the same cars being used for both coal and ashes.

Air Compressors.—The Nordberg Manufacturing Company furnished and erected, on foundations constructed by the Terminal Company, two cross-compound, two-stage, Nordberg-Corliss, air compressors, with such necessary appurtenances as steam receivers, intercoolers, etc., ready for steam, air, and exhaust connections. The steam cylinders are 14 and 24 in. in diameter, and the air cylinders 14½ and 24½ in., with a common stroke of 32 in.

The frames are of the heavy-duty type, having main bearing and slide in one casting, and resting on a base extending the full length of the frame. There is a heavily-ribbed, cast-iron, foundation plate extending under the air and steam cylinders. The fly-wheels are 10 ft. in diameter, and weigh 23 000 lb. The cylinders are tapped for an indicator, and polished brass pipe and valves are provided with a central T for attaching the indicator. There is a pressure regulator which maintains automatically a constant pressure of air by varying the speed of the engine. The governor is driven by a belt from the engine shaft. The air cylinders are of re-melted iron, cast in dry sand, and are water-jacketed on barrels and heads, insuring regular cooling throughout.

The steam cylinders are placed behind their respective air cylinders, and are fitted with the regular Nordberg-Corliss valves and valve gear, the high-pressure cut-off being under control of a combined speed and pressure regulator. A receiver, of the re-heater type, under the floor, is fitted with a pop safety-valve set at 50 lb. to prevent the low-pressure cylinder from being over-strained from excessive pressure.

There is a tubular inter-cooler, above and between the air cylinders, fitted with seamless, drawn-brass tubes, providing 450 sq. ft. of cooling surface, or ample to cool the air discharged from the low-pressure cylinder.

Each machine has a complete oiling system, comprising a hand pump for each cylinder, a trombone oiler for the cross-head pins, Nugent oilers for the crank pins, and Richardson forced-feed pumps for each steam cylinder, driven from a suitable place on the valve gear; all other working parts have suitable funnels connected with an elevated tank by piping. There are oil guards, of planished steel with polished corner strips, around the cranks and eccentrics, and properly tapped for the drainage of oil.

Each compressor has two Crosby, steam-engine indicators, one 100-lb. spring, one 80-lb. spring, and two 30-lb. springs, together with the following gauges: One air pressure, one steam pressure, one air pressure for inter-cooler, one compound for receiver, and one six-point counter, all with 8½-in. nickel-plated dials.

These machines furnish compressed air, at about 100 lb., for the operation of the electro-pneumatic signals connected with the New York Avenue, K Street, and Massachusetts Avenue interlocking plants, and for testing air brakes on passenger cars in the train yard. They also furnish the Franklin-type compressors with air at from 100 to 120 lb., which is in turn compressed to about 300 lb. for use in the hydraulic elevator system. When operating at 460 ft. piston speed, or about 86 rev. per min., non-condensing, with steam at 150 lb. pressure and 100° Fahr. superheat at the throttle, and back-pressure not exceeding 1 lb. at the nozzle of the low-pressure cylinder, they compress 1 500 cu. ft. of free air per min. to 100 lb. pressure. When running under the foregoing conditions the steam consumption should not exceed 5.8 lb. for each 100 cu. ft. of air compressed.

The Chicago Pneumatic Tool Company furnished two special, Franklin-type, class G-SS, single, steam-driven, air compressors, each having a capacity of 50 cu. ft. of free air per min., and capable of delivering compressed air under 320 lb. pressure. The steam cylinders are 8 in. in diameter, with a 12-in. stroke, and are designed for a steam pressure of 150 lb. with steam superheated 100° Fahr. The air cylinders are 6¼ in. in diameter, with a 12-in. stroke, and receive the air supply from the Nordberg compressors at from 100 to 120 lb. pressure, compressing it to about 300 lb. per sq. in. for use as a cushion in the pressure tanks of the hydraulic elevator system.

These compressors have single, straight-line, steam and air cylinders, and operate at 120 rev. per min. The cylinders and heads are completely water-jacketed, and are designed for thorough circulation, thus affording equal cooling throughout. They are provided with a pressure-regulating governor which controls automatically the operation of the compressor in accordance with the demand for air, working in conjunction with a speed governor which regulates the speed of the compressor. There is also an unloading device for relieving the compressor of all load when the desired pressure is obtained and causing it to resume delivery automatically when the receiver pressure is reduced.

These machines are assembled, aligned, and tested at the factory on a common base, and are shipped in one piece. Unless damaged in transit, there is no difficulty in putting them on foundations and getting them ready for service.

Turbo-Generators.—The Westinghouse Machine Company, of Pittsburg, Pa., furnished and erected four 500-kw., Westinghouse-Parsons, turbo-generator units, on foundations built by the Terminal Company. The steam turbine is known as the multiple-expansion, parallel-flow type, adapted for driving a direct-connected generator with a two-pole, revolving field, running at 3 600 rev. per min., and giving 7 200 alternations per min. The turbine and generator are mounted on a continuous bed-plate having suitable supports for turbine, generator, generator bearings, etc.

The condenser for each turbine is in the basement directly beneath it. They are of the Worthington surface type, with cast-iron cylindrical shells, and contain 1 600 sq. ft. of condensing surface. The condensing water is taken from the cooling tower, and circulated by 14-in., volute, centrifugal pumps.

The maximum length of turbine is 12 ft. 7 in.; the combined unit, 21 ft.; width, 4 ft. 5 in.; height above floor, 6 ft. 7 in.; approximate weight, 25 000 lb. Its capacity is 750 b.h.p. when operating at 3 600 rev. per min., with dry saturated steam of 150 lb. gauge pressure per sq. in. at the throttle, and with a pressure in the exhaust pipe of 25 in. vacuum, measured by a mercury column referred to a barometric pressure of 30 in. The contract provides that the steam consumption, including all steam consumed by the turbine and all leakages and losses, will not exceed the following quantities per British horse-power-hour when operating under the above conditions:

	25-in. vacuum.	26-in. vacuum.	27-in. vacuum.
Full load	16.3 lb.	15.6 lb.	15.1 lb.
¾ “	17.2 “	16.4 “	15.7 “
½ “	19.0 “	17.9 “	17.0 “
1¼ “	16.7 “	16.0 “	15.5 “
1½ “	18.3 “	17.3 “	16.7 “

When operating at the foregoing speed and steam pressure, but with a back-pressure in the exhaust pipe of 1 lb. and ½ lb., respectively, the steam consumption per British horse-power-hour will be as follows:

	1 lb.	½ lb.
Full load	34.3	33.9
¾ “	36.6	36.0
½ “	41.2	40.3

When operating at 3 600 rev. per min. with 150 lb. pressure at the throttle, but with steam superheated 100° Fahr. above the temperature of saturated steam, the steam consumption will not exceed the following quantities per British horse-power-hour:

	25-in. vacuum.	26-in. vacuum.	27-in. vacuum.
Full load	14.7 lb.	14.1 lb.	13.6 lb.
¾ “	15.5 “	14.8 “	14.1 “
½ “	17.1 “	16.1 “	15.3 “
1¼ “	15.0 “	14.6 “	14.0 “
1½ “	16.5 “	15.6 “	15.1 “

When operating under such conditions, but with a back-pressure on the exhaust pipe of 1 lb. and ½ lb., respectively, the steam consumption will be as follows:

	1 lb.	½ lb.
Full load..............	30.9	30.5
¾ “	32.9	32.4
½ “	37.1	36.3

Each turbine has a secondary governor-valve of the balanced, poppet-valve type, with which an overload of 50% may be developed, or a full load developed when operated without the condenser. This valve is operated automatically by a suitable mechanism in connection with the governor, and is arranged to open when the load exceeds the amount the turbine can carry when operating normally. It will also open should the vacuum or steam pressure fall to a point where the turbine is unable to carry the load normally, and will return to its seat automatically when the excess capacity of the turbine is no longer required. The speed is controlled by a sensitive governor operated by varying the admission of steam. The governor has an electrical speed-change device operated by motor.

The turbines are lubricated by a continuous circulation of oil supplied by a system of delivery and drain pipes, with a suitable reservoir in the bed-plate. A pump, driven by the turbine, together with a cooling coil, is furnished with each turbine.

The alternating-current generator is of the turbo type, and has two poles. The normal speed is 3 600 rev. per min., the frequency is 7 200 alternations or 60 cycles per sec., delivering three-phase current at 2 300 volts. The normal rating of the generator is 125.5 amperes per terminal at 2 300 volts and 100% power factor.

The efficiencies for these generators, based on the C^2R losses, armature iron loss at the normal rated current and voltage, and 100% power factor, are 92% at one-half load, 94% at three-quarters load, 95% at full load, 95.5% at one and one-quarter load, and 95.75% at one and one-half load. The generator is separately excited. When the generator delivers its normal rated current at normal voltage and 100% power factor, the field requires approximately 75 amperes at 100 volts, or 90 amperes when delivering its normal rated current at normal voltage and 90% power factor.

The armature is of the slotted-drum type, the core being built up of laminated steel of high magnetic quality. The armature winding consists of wire-wound coils, formed and insulated before being placed in the slots. The insulation of the conductors consists of material of high insulating quality applied in overlapping layers treated with moist and oil-proof compound. When completed, the insulation of the armature winding from the core was subjected to a momentary puncture test of 5 000 volts, alternating e.m.f.

The field core is of steel. The steel pole pieces and field winding are proportioned so as to reduce the armature reaction and self-induction to a low limit. The field coils are wound with strap copper, and are insulated from the core by layers of fibrous material. When completed, the insulation of the coils from the core was subjected to a momentary puncture test of 1 000 volts, alternating e.m.f.

The field winding is proportioned so that, with constant speed, constant separate excitation, and 100% power factor, the load may vary from full load to no load with a rise in voltage of approximately 10 per cent. The constant voltage is maintained by a Tyrill regulator.

The temperature in any part of the generator will not rise more than 40° cent. in 24 hours when delivering its normal current at normal voltage and 90 to 100% power factor, or more than 55° cent. with 25% greater current but the same voltage and power factor.

Cooling Tower and Surface Condenser Equipment.—Henry R. Worthington, of New York, furnished and erected, on foundations provided by the Terminal Company, a cooling tower and the necessary surface-condensing equipment for the power-house. The cooling tower is of brick on a concrete foundation, and is immediately north of the power-house. It has an inside diameter of 28 ft., a height of 38 ft. above the foundation, and contains about 12 000, 6-in., salt-glazed tiles, 24 in. long, with walls 1 in. thick, presenting a cooling surface of about 91 500 sq. ft.

The terra cotta baffles are built up in eight courses, the tiles standing on end, each course containing 1 490 tiles, making a stack 16 ft. high. The support for these baffles is 13 ft. above the foundation, and consists of I-beams, ranging from 18 to 24 in. in depth, spaced at 2½-ft. centers, built into the outer shell. Resting on the tops of these I-beams is a wrought-iron grating of ½ by 2½-in. flat bars, spaced at 5½-in. centers, separated by 5-in. sections of ½-in. wrought-iron pipe, secured by ⅜-in. bolts.

It is equipped for forced-air circulation with four 96-in. disk fans, driven in pairs by two 40-h.p. Westinghouse induction motors. The fans operate at 350 rev. per min., requiring 64 b.h.p. for each pair. It is capable of cooling the circulating water required to condense 30 000 lb. of steam per hour and maintain in the condensing apparatus a 26-in. vacuum on 30-in. barometer, with prevailing atmospheric conditions of 75° temperature and 75% relative humidity.

In the base or concrete foundation of the cooling tower there is a cistern or tank, 23 ft. in diameter and 11 ft. deep, for taking care of the cooled water, the side-walls and bottom of which were water-proofed with hydrolithic compound by the E. J. Winslow Company, of Chicago.

The circulating water is delivered near the top of the tower by a vertical, [illegible]in., cast-iron pipe in the center, and is distributed by eight perforated pipes attached at right angles to a cap at the top of the pipe, equally spaced over the area at the top of the tower. From these arms it falls to the tank. This pipe connects with the 24-in. discharge main near the bottom of the foundation, or 3 ft. 4 in. below the basement floor level.

The return to the condensing apparatus is a 24-in. cast-iron pipe, laid beside the discharge pipe, connecting with the cistern about 2 ft. above the bottom. There is a 3-in. cold-water supply pipe by which the water in the tank can be maintained at a regular level. Connecting with the sewer there is an 8-in., cast-iron, overflow pipe, the top of which is 6 in. below the top of the cistern.

The condensing apparatus, immediately beneath the turbines, consists of four 1 600-sq. ft. surface condensers, one for each turbine, two 8 by 16 by 12-in. vertical, single, double-acting, air pumps of the suction, valveless type, two 14-in., horizontal, special, volute, centrifugal, circulating pumps, and two 7½ by 7½ by 6-in., horizontal, duplex, low-service, piston-pattern pumps.

The condensers have cylindrical shells, of close-grained cast iron, with proper openings for exhaust, air, and circulating pipe connections, together with openings for cleaning and inspection. Baffle-plates distribute the steam and relieve the tubes of its impact. The tubes are of seamless, drawn brass, and are required to stand an internal cold-water test pressure of at least 500 lb.; they are in straight lengths, without upset or flanges, and pass through stuffing-boxes in the heads of the tubes. The stuffing-boxes have brass ferrules with a lip on the inside, for the purpose of securing the tube in position, and to prevent creeping, at the same time allowing freedom for expansion and contraction. By this arrangement any tube can be removed and any stuffing-box can be repacked in case of failure or leakage from long use.

Each circulating pump is capable of delivering 4 400 gal. of water per min. against a dynamic head of 50 ft., when operated at a speed not exceeding 325 rev. per min. The suction openings are 16 in. in diameter and the discharge openings 14 in. They are direct-connected, and are mounted on a common bed-plate with one 10 by 18 by 10-in., Westinghouse, compound engine, the two machines forming a self-contained unit. Each engine and air pump has a Richardson pump lubricator with a tank capacity of 0.8 gal.

The apparatus is arranged so that each turbine has an individual condenser. The vacuum pumps are arranged and proportioned so that each will take care of two units. The service or hot-well pumps are proportioned so that each can take care of the entire load of the four turbines, or 48 000 lb. of steam per hour. Under proper working conditions, each condenser is capable of maintaining a vacuum of 26 in., based on a 30-in. barometer, when each turbine is delivering to its condenser 12 000 lb. of steam per hour, provided a sufficient quantity of circulating water is furnished at a temperature not exceeding 85° Fahr. All steam-driven apparatus is constructed for a steam pressure of 150 lb. with superheat not exceeding 100° Fahr.

Electrical Equipment.—The Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., furnished and erected, on foundations built by the Terminal Company, the following electrical equipment: One alternating-current switch-board, one direct-current, exciter switch-board in the center of the room, one direct-current, Brush-arc switch-board at the south end of the room, one set of portable testing instruments, one 35-kw., engine-driven exciter, with engine, two 50-kw., motor-driven exciters, with motors, four sets of motor-driven, Brush-arc machines, each set consisting of one 200-h.p., induction motor, direct-connected to two No. 12-B, Brush-arc generators, two 10-h.p., CCL motors, one 10-kw., motor-driven, generator set, and two switch-boards for storage-battery charging sets, the latter located in the basement of the depot.

The alternating-current switch-board controls four 500-kw., 2 300-

volt., 3-phase, 60-cycle, turbine-driven generators, nine 3-phase, power circuits, and six single-phase, lighting circuits. There is a high-tension bus-bar and switch compartment of reinforced concrete in the basement of the power-house directly under the switch-board. There are two extra, generator, switch compartments, four extra, 3-phase, power, switch compartments, and two extra, single-phase, lighting, switch compartments to take care of the future extension of the equipment. There are also the necessary soapstone barriers for the disconnecting switches. All disconnecting and oil switches have a capacity of 300 amperes, the oil switches being distant-control, operated electrically by switch on the main switch-board.

The board consists of nine panels of blue Vermont marble, 16 in. wide, 90 in. high, and 2 in. thick, made in two sections, the upper section 65 in. long, the lower section 25 in. long, furnished complete with angle-iron frames, bus-bars, and supports. Panels 1, 2, 3, and 4 control the 500-kw., alternating-current, 3-phase, 60-cycle, 2 300-volt generators; Panels 5, 6, and 7 control the 3-phase, power feeders, and Panels 8 and 9 control the single-phase, lighting feeders. On each side of Panels 1, 2, 3, and 4 are mounted one polyphase, indicating, wattmeter, two type-F, alternating-current ammeters, one polyphase, integrating wattmeter, one 8-point, volt meter, receptacle, and plug, one synchronizing plug, receptacle, and indicating lamp, one turbine governor controller and indicating lamp, one rheostat controller with indicating lamp, one oil, circuit-breaker controller with indicating lamp, and one field-switch with discharge resistance. On Panels 5, 6, and 7, controlling nine 3-phase, power feeders, there are mounted, for each feeder, one polyphase, indicating wattmeter and one oil, circuit-breaker controller with indicating lamp. On Panels 8 and 9, controlling six single-phase, lighting feeders, there are mounted, for each feeder, one type-F, alternating-current ammeter, and one oil circuit-breaker controller and indicating lamp. On a swinging bracket at the end of the board there are two illuminated-dial, alternating-current, type-G, volt meters.

In the basement there are: in connection with each of Panels 1, 2, 3, and 4, one 300-ampere, 2 300-volt, 3-phase, type-F, oil switch, with tripping coil, one polyphase, reversed-current relay, six 300-ampere, 2 300-volt, single-phase, single-throw, disconnecting switches, and one electrically-operated, rheostat face-plate; with Panels 5, 6, and

7, for each feeder, one 300-ampere, 2 300-volt, 3-phase, single-throw, automatic, type-F, oil circuit-breaker, and six 300-ampere, 2 300-volt, single-pole, single-throw, disconnecting switches; and with Panels 8 and 9, for each feeder, one 300-ampere, 2 300-volt, two-pole, single-throw, automatic, type-F, oil circuit-breaker, and six 300-ampere, 2 300-volt, single-throw, single-pole, disconnecting switches.

The direct-current, exciter switch-board controls one 35-kw., 125-volt, direct-current, engine-driven generator, two 50-kw., 125-volt, direct-current, motor-driven generators, and three 300-ampere, 125-volt, direct-current feeders. The board consists of five panels of blue Vermont marble, 16 in. wide, 90 in. high, and 2 in. thick, made in two sections, the upper section 65 in. long and the lower one 25 in. long, with the necessary angle-iron frame, bus-bars, and supports. On the first or regular panel are mounted one 150-volt, type-D, direct-current, volt meter, one 6-point, volt meter, receptacle, and plug, mounting for one Tyrill regulator, and swinging bracket at the right of the panel for one 150-volt, type-D, volt meter. On each of Panels 2 and 3, or 50-kw. generator panels, are mounted one 600-ampere, type-D, direct-current ammeter, one field rheostat, one 4-point, volt meter, receptacle, and plug, one 600-ampere, 250-volt, three-pole, double-throw, type-D switch, and one Thomas, 400-ampere, 125-volt, recording wattmeter. On the fourth, or 35-kw. generator, panel are mounted one 400-ampere, type-D, direct-current ammeter, one field rheostat, one 4-point, volt meter, receptacle, and plug, one 600-ampere, 250-volt, three-pole, double-throw, type-D switch, and one Thompson, 300-ampere, 125-volt, recording wattmeter. On the fifth or feeder panel are mounted three 200-ampere, two-pole, single-throw, type-C, laminated, carbon-brake circuit-breakers, with low voltage release.

The direct-current, Brush-arc switch-board controls four pairs of motor-driven, 12-B, circuit, Brush-arc generators. The panels are 32 in. wide, 90 in. long, and 2 in. thick, with necessary angle-iron frames, bus-bars, and supports. Each panel has one direct-current, station ammeter, three volt-meter receptacles, four card holders, one name plate, eight ammeter jack receptacles and plugs, eight cable-transfer receptacles, and fifty-four transfer bus receptacles. In connection with each panel there is provided on swinging brackets one 300-volt, T.I.D., volt meter, with multiplier, four 5-ft., transfer cables, with two plugs each, and one 10-ft. ammeter cable and plug. Rubber mats, 2 ft. 9 in. wide and the full length of the switch-board, are provided with each of the boards.

The following portable testing instruments were provided with the equipment: One Westinghouse, alternating-current ammeter of 2½ and 5 amperes capacity; two Westinghouse, alternating-current ammeters with capacities of 5 and 10 amperes; one Westinghouse, polyphase indicating wattmeter, potential capacity 200 to 400 volts, current capacity 5 and 10 amperes; two Westinghouse, series transformers, capacity 25, 50, and 100 amperes; two potential transformers, 2 200-110 volts; one Weston, direct-current, volt meter, scale 0 to 150; one Weston, millivolt meter, scale 150 to 300; one Weston, portable shunt, 150-15 amperes; one Weston portable shunt, 600-300 amperes; one Weston, alternating-current, volt meter, 150-300 volts; one magneto, 25 000 ohms; and high-potential, testing transformer, capacity 5 kw., range 100-10 000 volts.

The engine-driven exciter consists of an 8-in., compound, Westinghouse engine, operating at a speed of 375 rev. per min., and having a normal rating of 55 i.h.p., with a maximum of 84 i.h.p. at 150 lb. steam pressure, direct-connected to a 35-kw., direct-current, compound-wound, engine-type generator, operating at 125 volts and 375 rev. per min. The motor-driven exciters consist of a 75-h.p., type-C, three-phase, 2 200-volt, 60-cycle, induction motor, and a 50-kw., direct-current, compound-wound, 125-volt generator, operating at 685 rev. per min., mounted on a common shaft and bed-plate.

The motor-driven, Brush-arc sets consist of a 200-h.p., 125-light, 2 200-volt, 3-phase, 60-cycle, induction motor, direct-connected to two 12-B, Brush-arc machines, complete with couplings mounted on a common wood base, the motor having an oil-immersed auto-starter of capacity to start at no load. The 10-h.p., CCL motors are 60-cycle, 220-volt, induction motors, operating at 850 rev. per min., with oil-immersed auto-starter and slide rails. The 10-kw. motor-generator set consists of a 10-kw., direct-current, compound-wound generator, operating at 125 volts at 1 120 rev. per min., and a 15-h.p., CCL, 220-volt, 1 120-rev. per min., 60-cycle, induction motor, mounted on a common shaft and bed-plate. The motor has an oil-immersed auto-starter, and the generator is furnished complete with a field rheostat.

The switch-boards for battery charging, in the concourse basement, are arranged as follows: No. 1 consists of three panels of blue Vermont marble, each panel 24 in. wide, 90 in. high, and 2 in. thick, divided into two sections, the upper 65 in. long and the lower 25 in. Panel 1 controls ten 100-ampere, regulating circuits, each taking care of a range in voltage of 60 volts, and has mounted upon it the following apparatus: Ten 100-ampere, 7-point, drum controllers, ten 100-ampere single-pole, double-throw knife-switches, and one 20-point, volt-meter receptacle, while on the back there are ten 100-ampere, enclosed fuses. Panels 2 and 3 are arranged to take care of 30 charging circuits of about 75 amperes each, and have the following apparatus mounted on each: 30 Anderson charging receptacles, 30 lamp brackets, and 30 5-c.p., 110-volt, incandescent lamps. Supplied with the panels are 10 Anderson charging plugs, each with 8 ft. of flexible cable. On swinging brackets at the ends of these panels there are one 150-volt, illuminated-dial, direct-current, volt meter, and one 150-ampere, illuminated-dial, direct-current ammeter. The second switch-board consists of two panels, Nos. 1 and 2, each being duplicates of corresponding panels on Switch-board No. 1. On swinging brackets at the ends of these panels there are mounted one 150-volt, illuminated-dial, direct-current, volt meter, and one 150-ampere, illuminated-dial, direct-current ammeter.

All wiring, except high-tension wiring, is in accordance with the November, 1903, Yards and Docks Specifications of the U. S. Navy, and all wires used in connection with the control board have flame-proof covering.

Refrigerating Plant.—The Carbondale Machine Company, of Carbondale, Pa., furnished and erected a Carbondale, absorption-type, refrigerating plant in the south end of the power-plant. It has a nominal cooling capacity equal to that of 50 tons of melting ice every 24 hours. It is capable of cooling from 75° to 40° Fahr., and circulating 600 gal. of drinking water per hour; cooling 30 000 cu. ft. of refrigerator boxes in the kitchen, serving-, and lunch-rooms to 38° Fahr.; 10 250 cu. ft. of space in the mortuary chamber to 32° Fahr., and freezing 50 gal. of ice-cream.

In performing this work, the drinking water is cooled by ammonia coils, and all other refrigeration by brine coils, the plant being guaranteed to cool 200 gal. of brine from a temperature of 0° to —5° Fahr. per min.

The plant is made up of the following parts: A generator, an

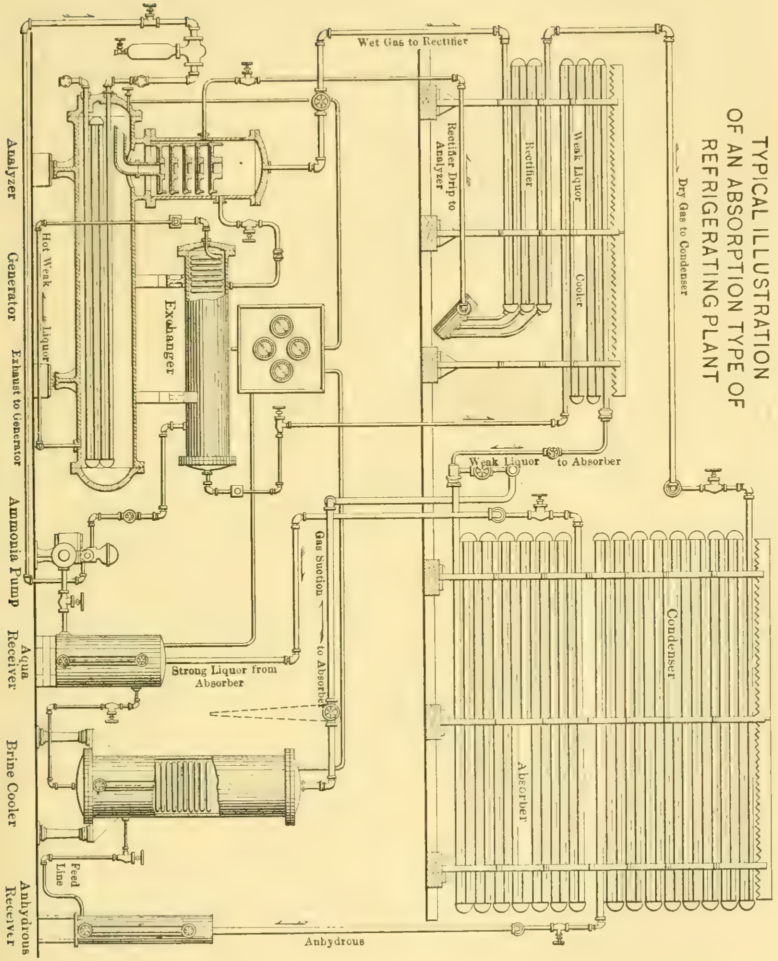

TYPICAL ILLUSTRATION OF AN ABSORPTION TYPE OF REFRIGERATING PLANT

FIG. 6.

analyzer, an exchanger, a rectifier, a condenser, an atmospheric absorber, a weak-liquor cooler, an anhydrous receiver, an aqua receiver, a brine cooler, two aqua ammonia pumps, two brine pumps and two drinking-water circulating pumps.

The generator has a cast-iron shell, about 14 ft. long, with a flanged **T** at one end to receive the analyzer shell, and four lugs at the other end for carrying the exchanger shell. Its steam coils are of heavy lap-welded pipe with cast-steel bends.

The analyzer has a cast-iron shell, about 4 ft. long, and rests on the **T**-nozzle of the generator. It has cast-iron analyzer trays caulked into the analyzer shell with lead packing. The exchanger is mounted on the lugs of the generator and supported on ornamental columns. It has a cast-iron shell, about 8 ft. long, and has spiral coils of 1-in. and 1¼-in. pipe.

The rectifier is of 3-in., lap-welded, extra-heavy, wrought-iron pipe submerged in a tank supported on iron standards above the generator. The condenser is of the atmospheric type, and is in four sections, each section containing 24 runs of 2-in., extra-heavy pipe. The brine cooler has a cast-iron shell, about 9 ft. long, and spiral brine coils, the inlet and outlet ends of which are connected with the brine circulating pipes.

The atmospheric absorber is in four sections, each having 15 runs of 3-in. ammonia pipe. The two aqua ammonia pumps are of the direct-acting type, and were built by the Foster Pump Works. The cylinders are 6 in. in diameter, with a stroke of 12 in. A set of four nickel-rim pressure gauges with 8-in. cases marked, respectively, generator, cooler, absorber, and steam, mounted on an ornamental iron frame with necessary shelf and brackets, and three sets of ¾-in. Ball gauge cocks with glasses for indicating the liquid level of the several parts, were supplied with this plant.

Each part of the machine was constructed to stand a test under hydraulic pressure of not less than 500 lb. per sq. in., before leaving the works, and all coils to stand an air pressure of not less than 300 lb. per sq. in. while submerged in water for the purpose of locating the leaks. The bodies of the generator, exchanger, analyzer, and cooler are covered with insulating material and finished with hardwood sectional lagging bound with nickel hoops. This apparatus is operated by city water and superheated steam at 150 lb. pressure, and to do the necessary pumping and refrigeration will require not more than 2 800 lb. of superheated steam. The steam for operating the generator is obtained from the exhaust of the ammonia, brine, and drinking-water circulating pumps.

The brine is drawn from a storage tank and circulated through the brine cooler of the refrigerating machine by the brine-circulating pump. The cooled brine is discharged from the cooler coils and forced about 1 800 ft. to the brine coils in the service- and storage-rooms at the station, thence it is returned to the brine tank at the power-house to be cooled again. The brine coils in the cold-storage rooms are of 1-in. galvanized-iron pipe, and have return bends at 4½-in. centers and coils about 100 ft. run, each coil being controlled by a valve at inlet and outlet and fitted with a ¼-in. cock for the removal of air. The main from the brine tank to the pump suction is 4 in. in diameter, that from the pump discharge to the cooler inlet is 3 in.

The brine pumps are of the duplex, double-acting, service type, built by the Deane Pump Works, with 6-in. cylinders and a 12-in. stroke. The brine-storage tank has a capacity of 3 500 gal., and is in two sections, each 15 by 3 by 6 ft. The brine is made of "Solvay" chloride of calcium, 1.225 specific gravity.

The drinking-water circulating system is arranged as follows: Water is supplied to the storage tanks under city pressure, the supply being controlled by a float-valve, and is cooled by circulating ammonia coils submerged in the tanks. From these tanks the water is circulated by pumps through the flow and return mains to the drinking fountains in the station and in the express building.

The water-cooling and storage tank, in two sections, each 10 by 3 by 6 ft., is in the power-house, and has a capacity of 1 500 gal. It contains 200 lin. ft. of galvanized, jointless, direct-expansion, ammonia coils, in sections, each controlled by inlet and outlet valves. The water-circulating pumps are of the double-duplex type, the pump cylinders, 4½ in. in diameter with a 12-in. stroke, are bronze-fitted on the plunger end. They were built by the Deane Pump Works.

The operation of this plant is briefly as follows: Sufficient commercial aqua ammonia to submerge the coils completely is placed in the generator shell. When heat is applied, by passing exhaust steam through the coils, the aqua ammonia gives up some of its vapor, which passes through the analyzer to the rectifier, where any water vapor is trapped and returned through a drip line to the analyzer, from which it passes by gravity into the generator. This ammonia gas, which is hot and at a high pressure, after leaving the rectifier passes into the condenser where it is cooled to a point at which it liquefies under that pressure. The pressure in the generator, rectifier, and condenser is fixed by the temperature of the condensing water.

This liquefied anhydrous ammonia then flows into a receiver having gauge glasses for the purpose of indicating the level of the liquid. The anhydrous ammonia is then admitted into the brine cooler by an expansion valve, and there, owing to its expansion from the high pressure of the condenser to the low pressure of the cooler, it is converted to a gas. This change of state absorbs heat from the brine which is being circulated through the coils in the cooler by the brine pump.

The ammonia gas, having performed its function in the brine cooler, is now returned to the generator by the absorber, which consists of a vertical stand of pipes over the outside of which water from the condenser passes for the purpose of cooling it. The ammonia gas is drawn from the cooler into the absorber by reason of its affinity for water. In order to utilize this property, advantage is taken of the fact that, owing to the difference in specific gravities, the weakest aqua ammonia lies in the bottom of the generator. A small pipe, therefore, is led from the bottom of the generator through the coil in the exchanger, thence through the weak-liquor cooler to the absorber, where, by a spray valve, the weak ammonia liquor mixes with the gas coming from the brine cooler, absorbs it rapidly, and produces a suction action which tends to draw gas from the cooler continuously.

The mixing of the weak liquor with the strong gas from the cooler forms strong aqua ammonia, which flows from the absorber to the aqua receiver, from which it is pumped by a small direct-acting pump through the exchanger into the analyzer, from which point it flows by gravity into the generator. In this way the strength of the solution in the generator is maintained and the operation of distillation is made continuous.

The exchanger is installed in the interest of economy in steam, as follows: The hot weak liquor, in passing from the generator to the weak-liquor cooler, passes through the exchanger, where its heat is utilized in raising the temperature of the strong aqua ammonia coming from the absorber; conversely, the cold, strong aqua ammonia assists in cooling the weak liquor on its way to the weak-liquor cooler. The colder the weak liquor the more gas it will absorb, and the warmer the strong ammonia is when reaching the generator the less heat will be required to generate the gas.

The practical working of a machine of this style is very simple. Under proper operation of the steam-pressure regulating-valve the distillation is practically uniform. The speed of the ammonia pump is controlled by a float-valve which maintains a constant level in the aqua receiver and generator. Under the above conditions the only variation is in the expansion-valve, which must be regulated to suit the temperature desired in the brine cooler. When the cooling load is fairly constant very little adjustment is necessary in any of the valves, as long as the steam pressure is unchanged.

The advantages of the absorption system are its ability to utilize exhaust steam, the possibility of obtaining lower temperatures than from compression machines of the same rated capacity, the durability of the parts, simplicity of operation, absence of noise and vibration, minimum number and low speed of moving parts, adaptability to space conditions, and safety with regard to fire insurance.

Crane.—The Niles-Bement-Pond Company, of Philadelphia, Pa., furnished and erected an overhead, three-motor, electric, traveling, 10-ton crane, in the engine-room on a runway put in in connection with the structural steel framework of the power-house, the span being 32 ft. 3 in., or approximately the width of the room.

The hoist is designed for a working load of 20 000 lb. and a test load of 25 000 lb., with a maximum lift of 36 ft. The running rigging is extra-pliable, plow-steel, wire rope. The hoist is operated by a 20-h.p. motor, and has a speed of 20 ft. per min. under full load, and 40 ft. under no load. The trolley motor is 3-h.p., with a speed of 100 ft. per min. under full load, and 125 ft. under no load. The bridge motor is 7½-h.p., and has a speed of 250 ft. per min. under full load, and 300 ft. under no load. The girders are of the box type; the motors and controllers are of the Niles type, and operate by direct current at 125 volts.

Blow-off Tanks.—At the base of the chimney there are two blow-off tanks, each 12 ft. long, 57 in. in diameter, and of ⅜-in. steel plates. The boilers are connected with these tanks by a 3-in. main, with 2½-in.

front and rear connections with each boiler. Each tank has a capacity of about 1 750 gal. There is a 6-in. connection between the tops of the tanks and the exhaust riser in the stack, and sewer connections are made with the bottom of each tank.

Oil Filters.—An oil-filtering system, consisting of two 300-gal. filters connected to one 250-gal. storage tank, three 60-gal. oil-storage tanks, one storage reservoir, 18 in. in diameter and 72 in. high, two cast-iron, galvanized sinks, and two 3 by 2 by 3-in. duplex, double-acting, steam pumps, with the necessary fittings, was furnished by the American Automatic Oil Filter Company, of Philadelphia, Pa.

Piping System.—All piping in the power-plant and between the power-plant and the station and express building, except that in the drinking-water and brine-circulating systems, was put in by W. K. Mitchell and Company, of Philadelphia, Pa. The drinking-water piping was put in by the Wells and Newton Company, of New York, and the brine piping by the Carbondale Machine Company, of Carbondale, Pa.

The arrangement of the steam piping in the power-plant is very simple. It consists essentially of a 10-in. main header extending the length of the boiler-room and in the rear of the boiler settings. The connections between the boilers and the header are made through the super-heaters by a 6-in. branch connecting the outlet of each superheater by a long-radius bend with the top of the header.

The header is divided into ten sections, with valves and by-passes, one for each boiler unit installed, with three sections blank for future extension of boiler units. Short direct connections are made with the steam-using machinery in the engine-room through openings in the longitudinal wall between the engine- and boiler-rooms. The blow-off piping consists of 3-in. mains, with 2½-in. front and rear connections with each boiler, and a 6-in. connection between the blow-off tanks and the exhaust riser in the stack.

The water supply for the power-plant, station, express building, and train yard is received through the power-plant from two sources: A 12-in. connection with a 24-in. main on K Street, and a 12-in. emergency connection with a 12-in. main on H Street, a T being provided in the line opposite the southwest corner of the power-house, with the necessary valves and by-passes. From this point the supply is carried to the various tanks in the south end of the plant, to the condensing machinery, feed-water heaters, and pumps.

The circulating piping between the condensing machinery and the cooling tower consists of a 24-in. suction line and a 24-in. discharge line, the latter terminating in an 18-in. stand-pipe in the center of the tower. There is also a 3-in. cold-water connection and an 8-in. overflow between the cooling tower cistern and the power-house.

The general piping between the power-plant and the station and express building, most of which connects directly with the power-house equipment, consists of: A 2-in. drinking-water circuit to the station and a 1-in. circuit to the express building; a 3-in. brine-circulating system to the station; an 8-in. hydraulic-elevator circuit (with 4-in. branches at H Street leading to the express building and 6-in. branches at the concourse, one group leading to the baggage elevators in the south end of the train yard, the other to the elevators in the station proper); a 16-in. exhaust steam line for heating, with an 8-in. branch to the express building; a 4-in. return for condensation from the station and express building; an 8-in. steam line for car-heating and cooking (branching near H Street into a 4-in. line to the express building, a 3-in. line to the station, and a 6-in. line to the concourse, at which point a 3-in. branch is carried into the station, the 6-in. line running along the concourse for car-heating on the station tracks); an 8-in. fire line, with a 6-in. branch to the express building; a 6-in. water line, with a 3-in. branch to the express building; a 3-in. air line to the concourse, with a 3-in. branch to the express building and a 1½-in. air line for the elevator system, with a 1½-in. branch to the express building.

Rolled-steel, lap-joint flanges were used in joining all these pipes except the smaller sizes, which were put together with screw flanges. Expansion bends were used in the 4-in. steam return and in the 6-in. live-steam supply in the main tunnel. Expansion joints were used elsewhere on all steam supply and return lines.

Pipe Covering.—All the piping, except the drinking-water circuit, was covered by the Philip Carey Company, of Lockland, Ohio. On all the pipes, valves, fittings, and flanges of all high-pressure steam lines, high-pressure steam drips, exhaust lines, and return hot-water lines, 85% magnesia sectional covering was used. The thickness of the covering on all high-pressure steam lines and other lines 8 in. in diameter and greater was 1½ in.; on all lines more than 1 in. and less than 8 in. in diameter, it was 1 in.; and for lines 1 in. in diameter and less, ⅞ in.

The covering was secured by staples applied along the joints at intervals of 6 in., and bound with No. 18 galvanized-iron wire at intervals of 12 in. The joints and cracks between the sections of covering were carefully filled and pointed with magnesia cement. Over this covering was placed an 8-oz. duck jacket, securely stitched in place and finished with two coats of approved paint. The brine piping, including the valves, fittings, and flanges, has sectional, cork covering, 2½ in. thick. The sections were cemented together, bound with No. 18 galvanized-iron wire, and finished with two coats of hot asphaltum. The pressure and discharge lines for elevators, fire lines, building service, and air lines, including valves, fittings, and flanges, have sectional cork covering, 1 in. thick, cemented and bound as above, and covered with an 8-oz. canvas jacket, finished with two coats of approved paint.

The Philip Carey Company also applied covering to boiler drums, feed-water heaters, and turbine connections, lined the boiler nozzles, smoke-flues, and uptakes, and cleaned and painted pipes and miscellaneous apparatus in the plant.

Elevator System.—An elevator system, exclusive of the general piping, was put in by Morse, Williams and Company, of Philadelphia, now the Otis Elevator Company. It consists of one baggage, one freight, and two passenger elevators, and three dumb-waiters in the station, three baggage elevators in the basement under the concourse, eight baggage elevators in the train yard along the north line of the concourse, five express elevators in the express building, and one freight elevator each in the power-house and inspectors' building.

With the exception of the dumb-waiters, the entire system is of the hydraulic-plunger type, operated under a closed-tank system, with pressure at the pumps of from 300 to 320 lb. per sq. in. on the supply line and back-pressure of about 20 lb. on the return line. Discharge tanks were placed in the attic, but, owing to the fact that there are individual pressure and discharge tanks at each elevator, more satisfactory operation has been obtained without the use of the attic tanks. The dumb-waiters are operated by electric motors.

Table 2 shows the numbers by which the elevators are now designated, the letters used by the architects in designating the groups when the contract was made, the location, kind of service performed, the rise, and the number and size of tanks used on the pressure and discharge lines at each elevator. The pressure tanks as arranged have

TABLE 2.—Elevator System in the Washington Terminal.

Number.	Letter.	Location.		Service.	Rise.	Number and Size of Tanks.	
						Pressure.	Discharge.
1	A	West office entrance	Station	Passenger	First to third floor	2—2 ft. 6 in. by 10 ft. 8 in.	2—2 ft. 6 in. by 10 ft. 8 in.
2	C	Baggage checking-room	"	Baggage	Basement to first floor	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
3	B	East office entrance	"	Passenger	First to third floor	2—2 " 6 " " 10 " 8 "	2—2 " 6 " " 10 " 8 "
4	D	Service-rooms	"	Freight	Basement to third floor	2—2 " 6 " " 10 " 8 "	2—2 " 6 " " 10 " 8 "
....	....	Serving-room	"	Dumb-waiter	First to kitchen	....	....
5	F	East basement	Concourse	Baggage	Basement to sub-basement	1—2 ft. 6 in. by 10 ft. 8 in.	1—2 ft. 6 in. by 10 ft. 8 in.
6	E	Baggage-room	"	"	" " "	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
7	E	" "	"	"	" " "	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
8	H	Train yard	Low level	Inv. and Bagg.	Concourse to sub-basement	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
9	I	" "	" "	Baggage	Low level to sub-basement	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
10	I	" "	" "	"	" " " "	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
11	I	" "	" "	"	" " " "	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
12	I	" "	" "	"	" " " "	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
13	G	" "	High level	"	High level to baggage-room	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
14	G	" "	" "	"	" " " " "	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
15	G	" "	" "	"	" " " " "	1—2 " 6 " " 10 " 8 "	1—2 " 6 " " 10 " 8 "
16	M	Express building		Express	Basement to first floor	2—2 " 6 " " 5 " 8 "	2—2 " 6 " " 5 " 8 "
17	M	" "		"	" " second floor	2—2 " 6 " " 5 " 8 "	2—2 " 6 " " 5 " 8 "
18	M	" "		"	" " first floor	2—2 " 6 " " 5 " 8 "	2—2 " 6 " " 5 " 8 "
19	M	" "		"	" " second floor	2—2 " 6 " " 5 " 8 "	2—2 " 6 " " 5 " 8 "
20	M	" "		"	" " " "	2—2 " 6 " " 5 " 8 "	2—2 " 6 " " 5 " 8 "
21	....	Power-house		Freight	" " attic	....	....
22	N	Inspectors' building		"	" " track level	....	....
....	....	At pumps		....	....	2—4 ft. 8 in. by 13 ft. 8 in.	6—2 ft. 6 in. by 10 ft. 8 in.

capacities equal to six times the discharge of the plungers, and are filled with air and water in equal proportions.

Each passenger elevator has a lifting capacity of 3 000 lb. at a speed of 250 ft. per min., and, with a load of 1 200 lb., a speed of 350 ft. per min. can be attained. The freight elevators have a capacity of 3 500 lb. at a speed of 250 ft. per min., and a maximum lifting capacity of 5 000 lb. at a slow speed. The baggage and express lifts have a capacity of 7 000 lb. at a speed of about 50 ft. per min. Two of the dumb-waiters have a capacity of 100 lb. at a speed of 200 ft. per min., the third has a capacity of 250 lb. at a speed of 100 ft. per min.

All the cylinders are encased in $\frac{3}{8}$-in. wrought-iron casings for their entire depth, and made of standard wrought-iron pipe, with outside couplings and inside brass liners at the joints. The plungers are of heavy steel tubing, surfaced and polished in lathes. The cars of the passenger and service elevators in the station are of mahogany and ornamental iron. The floors and platforms of all elevators are of clear quarter-sawed maple.

The two passenger elevators and the service elevator in the head-house have flash-light annunciators, and are controlled by a wheel and cable-operating device. There is also a safety device which prevents the doors from being opened except by the operator in the car, and locks the controlling device when the car is at a landing with the door open, thus the car cannot leave the floor until the door is closed.

The baggage and express elevators, and the freight elevators in the power-house and inspectors' building are operated by hand cables. At each floor they have substantial iron enclosures, with gates arranged to be raised at each floor by an operating device on the lift. There are iron shields or deflectors on the under side of all floor openings. The dumb-waiters are operated by a system of push-buttons; the doors must be closed before the car leaves the floor, and cannot be opened until it arrives at the landing to which it is dispatched.

The general piping for the elevator system was furnished and put in by W. K. Mitchell and Company, of Philadelphia, Pa., and included the supply and return pipes extending from the power-house through the pipe tunnel to the station, and thence by all elevators and connecting with the pipes leading to the tanks in the attic. All elevator pipes in the station and express building are laid in concrete trenches covered with cast-iron plates.

Express Facilities.—A 60 by 450-ft. building was erected along Second Street between H and K Streets, N. E., opposite the power-house, for the Adams, Southern, and United States Express Companies. The structure is of brick and steel, with a roof of red Spanish tile, the architectural treatment and general construction being similar to that of the power-house on the opposite side of the yard. The two structures form a group of buildings of very pleasing design flanking the entrance to the train yard.

The express building consists of a basement, with underground driveways 35 ft. wide along the east and west sides and north end; a main or track-level floor, with driveway along the east side and tracks adjoining the west side and north end; a second or office floor; and an attic or storeroom. The floors of the basement and main story are of concrete, the other floors are of wood. Fire-walls divide the building into three sections, the southernmost being used by the United States Express Company, the other two by the Adams and Southern Express Companies, jointly.

The building has five hydraulic-plunger elevators, three extending from the basement to the office floor, and two from the basement to the main floor only. It is lighted by electricity, the office floor by incandescent lamps, the other floors by arc lamps. Fire protection is provided by hydrants outside and hose connections on fire-risers inside the building. There are two fire-proof vaults on each floor, including the basement, one in the section occupied by the United States Company, the other in that occupied by the Adams and Southern Companies. There are drinking fountains, connected with the general drinking-water system, in all parts of the building.

The tracks approach the building at an angle of about 13°, so as to provide more standing room for cars. They are in pairs and are separated by trucking platforms, the entire layout having a capacity of about 27 cars. The tracks and platforms are covered for some distance from the building by concrete-steel shelter sheds for facilitating the handling of express matter in inclement weather.

All work in connection with the construction of the express building, power-house, and K Street interlocking tower, except furnishing and erecting the steelwork, and putting in the electric conduits and lighting fixtures, was done by James Stewart and Company, of New York. The steelwork was furnished and erected by the American

Bridge Company, of New York, and the electrical work was done by A. S. Schulman, of Cincinnati, Ohio. These structures are more fully described elsewhere in this paper.

The umbrella sheds and platforms, to which reference is made elsewhere, and the stairways leading from the concourse to the low-level tracks, were also constructed by James Stewart and Company, who furnished all labor and material, except for the conduits and lighting fixtures, which were provided and put in by Mr. Schulman. The architectural work was executed by D. H. Burnham and Company, of Chicago.

INTERLOCKING.

Three electro-pneumatic interlocking plants were put in by the Union Switch and Signal Company, of Pittsburg, Pa. One is between New York Avenue and Florida Avenue, on the west side of the tracks of the Metropolitan Branch of the Baltimore and Ohio Railroad, known as the New York Avenue Tower. It controls the switches and signals of the scissors-crossing at the point of convergence of the railroad lines entering the terminal from the north, and the switches and signals governing the movements of equipment between the coach and engine yard and the station. Another is at the south side of K Street, in the center of the throat of the train yard, and is known as the K Street Tower. It controls the switches and signals governing the movements in and out of the train yard. The third is immediately north of the concourse line, at the entrance to First Street Tunnel. It controls the switches and signals under Massachusetts Avenue Plaza, and is known as the Massachusetts Avenue Tower.

In addition to the interlocking plants, as above noted, there is an intercommunication system connecting with the outlying towers, and a train-starting signal system, the latter being the first of its kind to be put in service.

The New York Avenue machine has a 71-lever frame with 58 working levers; the K Street, the largest of the group, has a 191-lever frame with 162 working levers; the Massachusetts Avenue, the smallest of the three, has a 29-lever frame with 20 working levers. Out of a total of 291 lever spaces in the three machines, there are 240 active levers, leaving 51 spaces for future extensions. There are 108 working switch levers, operating 73 single switches, 5 derails, and 43 slip-switches with movable-point frogs. There are 106 working signal levers, operating 251 three-position signals and 157 two-position signals, or a total of 408 signals. Of the working signals, 30 are light signals at the Massachusetts Avenue plant for tunnel operation. In addition to the total of 408 working signals, there are 164 fixed blades for carrying out the speed-signaling principle.

The adoption of electro-pneumatic machines with right-and-left lever operation, effected a saving of 90 signal levers over any other type of power machine, and a consequent reduction in the size of the towers. There was also a great saving of space in the yard over what could have been accomplished with any other than a straight electric plant. The pipes, racks, cranks, and other equipment of a manual machine could not have been put in to operate the large number of switches and signals in these localities without interfering seriously with the track layout.

The New York Avenue Tower is a three-story-and-basement structure, 12 ft. 10 in. wide and 31 ft. 6 in. long, with one-story extensions, 12 ft. 10 in. wide and 30 ft. long, at each end. The basement is of concrete, the first and second stories of brick, and the third of frame construction covered with sheet copper. The roof is of wood covered with Ludowici tile. The basement contains the heating apparatus, coal bins, and transformer vault. The offices, repair-room, battery-room, and toilet are on the first floor. The relays and switch-board are on the second floor. The machine, track diagram, telegraph instruments and indicators, and push-button cabinets used in connection with the intercommunication system are on the third floor.

The K Street Tower is a three-story-and-basement structure, 12 ft. 10 in. wide in the basement, first, and second stories, and 61 ft. long. The third story is 15 ft. wide and 61 ft. long. It has a one-story extension, 12 ft. 10 in. wide and 45 ft. long, at the north end, and another at the south end of the same width and 50 ft. long. The basement is of concrete, and extends the entire length of the tower, including the extensions. The first and second stories are of brick and the third story of steel framework and terra cotta covered with copper. The roof is a steel frame with book tile, cinder concrete, and red Spanish tile. The basement contains the transformer vault, battery racks, and racks for cables. The first floor is used for offices, storeroom for repair material, toilet, and room for motor-generator set. The switch-boards, relays, and the spring combination plates and rollers of the interlocking machine are on the second floor. The combination plates and rollers are mounted vertically and attached to a structural steel frame provided especially for this purpose. This arrangement was found necessary on account of the large amount of selecting for the control of the home signals and electric detector circuits, and more especially the selecting for the third position of the signals.

The Massachusetts Avenue Tower is a one-story-and-basement structure, 15 ft. wide and 19 ft. long. The basement is of concrete and brick, the first story of steel frame and hollow tile covered with copper. The roof is a steel frame with book tile, concrete, and red Spanish tile.

The machines in these towers are of the Union Switch and Signal Company's standard electro-pneumatic type, with standard equipment for electric detector circuits, which, through the use of electric indication locks, prevents the switch levers from being moved out of position if the relays of any of the track circuits affecting any particular switch are opened by the presence of a train on these particular track circuits. The track circuits are arranged so as to obtain the maximum protection, both for the switch-point itself and all fouling movements, and, with this end in view, the track circuits are carried at least 100 ft. ahead of all switch-points, and in every case as far back as the fouling point. In the case of the ladder containing double slip-switches, the detector circuits were carried, with slip-switches reversed, to the circuit on the next parallel track, by a selection on the lever roller. This is done when sufficient facing-point protection cannot be obtained without locking the switches unnecessarily.

The illuminated track diagrams consist of a miniature reproduction of the entire track layout controlled from each machine, supported on iron-pipe stanchions at the backs of the machines at a convenient height for quick reading by the operators. The fronts of the diagrams are of glass painted black, except for the long slots representing the tracks, behind which there are 1-c.p., 14-volt lamps. Aluminum partitions separate the diagrams into sections representing those of the track. The lamps for lighting this diagram burn continuously except when track sections are occupied by trains, when the current is cut off automatically. The wires between the controlling relays and the lamps in the model are carried in the iron-pipe stanchions supporting the model.

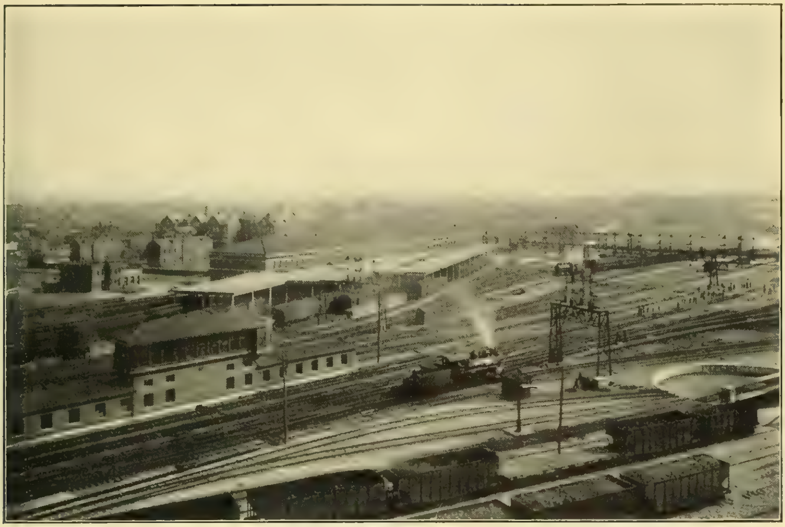


FIG. 1.—WASHINGTON TERMINAL STATION: GENERAL VIEW OF THROAT OF TRAIN-YARD.

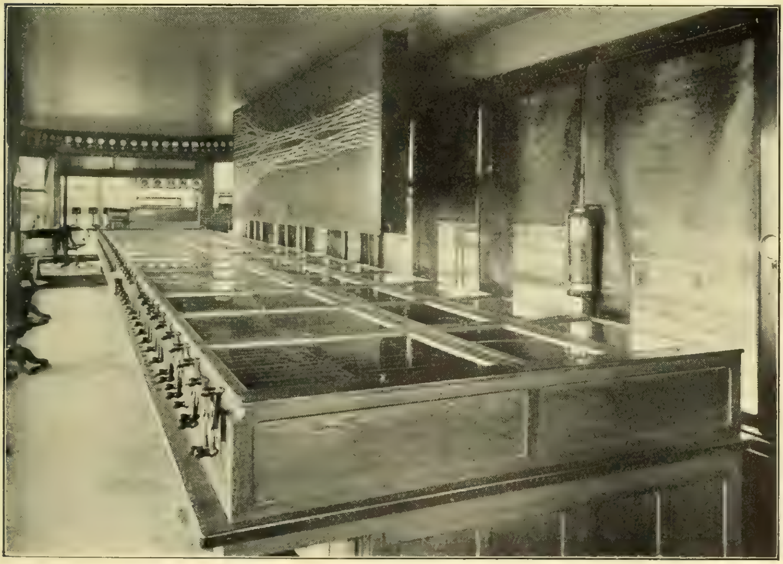


FIG. 2.—INTERIOR VIEW OF K STREET TOWER.

This design for track diagrams has some points of superiority over the mechanically-actuated track model, particularly that feature by which the locations of trains are shown in the territory covered by the diagram. The usual form of mechanical model only shows the routes set up, with no visible apparatus permitting one to follow the movements. The model in the K Street Tower is the largest ever built, being 19 ft. 6 in. long, 5 ft. 4¾ in. wide, and 9 in. thick. It contains 750 lamps, arranged to repeat 130 track sections, and is a fine example of good design and workmanship.

A system of locking has been established between the three towers described and the outlying towers at Second Street and Virginia Avenue, on the southern connection; at Rhode Island Avenue, on the Baltimore and Ohio Railroad's western connection; and at 12th Street and New York Avenue, on the Baltimore and Ohio and the Philadelphia, Baltimore, and Washington Railroad's eastern connection, by which movements opposing the established direction of traffic on tracks connecting all towers are prevented.

In designing the signal layout on the terminal property, the three-position speed system, with signals in the upper quadrant, was adopted. The upper arm in all cases controls the highest speed routes; the second or middle arm controls all routes where moderately high speed can be maintained, and the lower arm in all cases leads to routes where only low speeds are permissible. The low-speed signals, however, are provided with a special circuit, in which, by means of a push-button operated by permission of the train director, a stick relay may be thrown in series with the magnet of the low-speed arm, clearing the latter for the different routes which may be occupied. All signals assume automatically the clear 90° position from the next high-speed signal ahead over the route set up, providing the signal in advance is in the caution 45° or clear 90° position.

The signals are supported on 18 signal bridges, 9 of which were furnished by the American Bridge Company, of New York, 5 by the Toledo-Massillon Bridge Company, of Massillon, Ohio, and 4 by Barber and Ross, of Washington, D. C. The bridges range in length from 33 to 145 ft., and all but those furnished by Barber and Ross are supported on steel bents anchored to concrete foundations. Those furnished by Barber and Ross are supported on the tops of the umbrella sheds near the north entrance to the First Street Tunnel, and carry signals controlling movements into the tunnel.

Each tower is provided with duplicate groups of batteries of such number of cells as to meet the requirements; these are either in the battery-room in the tower or in boxes or cupboards in the bents of the signal bridges, distributed as shown in Table 3.

TABLE 3.—STORAGE BATTERIES FOR INTERLOCKING PLANT.

Tower.	Number of cells.	Where placed.
New York Avenue, or "C" Tower.	70	Battery-room, "C" Tower.
	10	Box, west end, Signal Bridge "K."
	8	Box, east end, Signal Bridge "M."
	4	Box, west end, Signal Bridge "L."
	4	Automatic signals. Metropolitan Branch.
K Street, or "K" Tower..........	112	Battery-room, "K" Tower.
	8	Box, east end, Signal Bridge "E."
	8	Box, west end, Signal Bridge "E."
	12	Box, west end, Signal Bridge "H."
Massachusetts Avenue, or "A" Tower............................	158	Battery-room, "A" Tower, in middle wall.
	6	Box No. 1, First Street Tunnel.
	2	Box at Signal No. 1366, First Street Tunnel.

Eighty ampere-hour storage batteries of the chloride accumulator type, furnished by the Electric Storage Battery Company, of Philadelphia, Pa., are used for energizing the track circuits, indicators, relays, and electric locks.

The batteries are in duplicate in order to permit the charging of one half while the other half is discharging, without influencing the discharging side. All cells are grouped and located at each point so as to operate the various functions for a period of 4 days as a minimum from one charging. For charging, the batteries are connected in series, and for discharging, in parallel. This operation is effected by special switches.

All the 2-volt track batteries discharge in multiple, but in the interlocking batteries, where from 12 to 14 volts are used customarily, the cells are arranged for discharge in groups of seven cells each, in series, and a sufficient number of these series are grouped in parallel to last the required 4 days. The batteries are charged from K Street Tower, where the motor-generator set is located. There are 263 track circuits in the layout, representing the equivalent of 18 miles of single track, and all are fed from storage batteries at 2 volts.

There are 734 relays in the entire layout, 263 of which are track relays. All are enclosed in suitable cupboards and cases. Those

PLATE CXIX.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
STROUSE ON
THE WASHINGTON TERMINAL STATION.

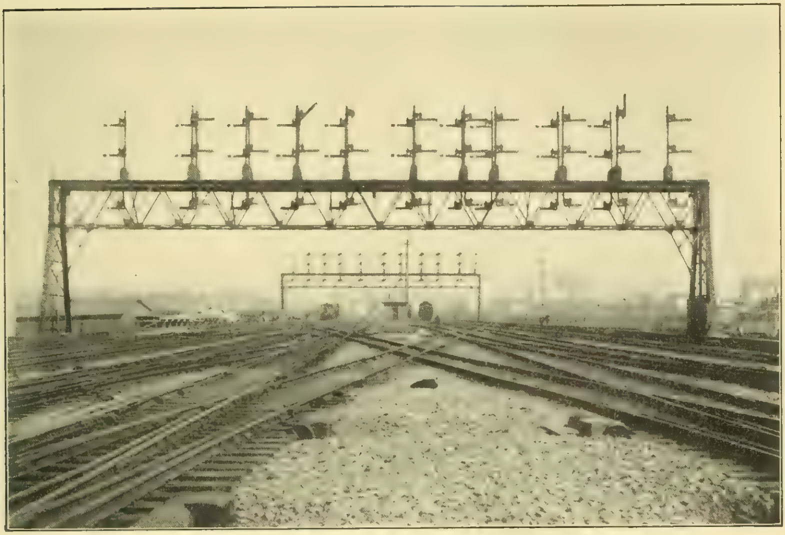


FIG. 1.—WASHINGTON TERMINAL STATION: SIGNAL BRIDGE AT DIAMOND CROSSING.

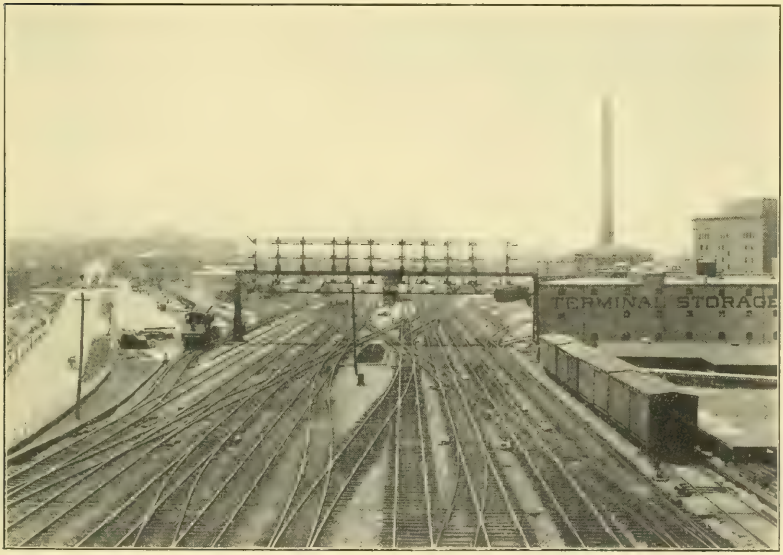


FIG. 2.—GENERAL VIEW OF NORTH APPROACH TO STATION.

scattered over the yard are housed in cupboards built in the bents of the signal bridges. In the towers the relays are enclosed in a combined rack and terminal board, suggested by the Signal Company, but built by the Terminal Company, in which all relays and wires are readily accessible. Flexible electric-light cord is used between the binding posts on the relays and those on the terminal board, so that the relays can be handled and inspected without disturbing the connections. The relays are distributed as shown in Table 4.

TABLE 4.—NUMBER OF RELAYS IN INTERLOCKING PLANT, AND THEIR DISTRIBUTION.

Tower.	Number of relays.	Capacity.	Where placed.
New York Avenue, or "C" Tower.	9	12-ohm	Box, west end, Signal Bridge "K."
	17	12-ohm	Box, west end, Signal Bridge "L."
	5	12-ohm	Box, west end, Signal Bridge "N."
	2	12-ohm	Signal No. 52-L, Washington Branch, P. R. R.
	2	12-ohm	Signal No. 60-L, Metropolitan Branch, B. & O. R. R.
	2	12-ohm	Automatic Signals, Metropolitan Branch.
	2	12-ohm	Signal Bridge "R," Washington Branch.
	12	12-ohm	Relay-room, "C" Tower.
	26	150-ohm	" " " "
	62	1 000-ohm	" " " "
K Street, or "K" Tower.	4	12-ohm	Box, east end, Signal Bridge "A."
	4	12-ohm	Box, east end, Signal Bridge "B."
	12	12-ohm	Box, center of Signal Bridge "C."
	13	12-ohm	Box, center of Signal Bridge "D."
	13	12-ohm	Box, east end, Signal Bridge "E."
	11	12-ohm	Box, west end, Signal Bridge "E."
	8	12-ohm	Box, east end, Signal Bridge "F."
	11	12-ohm	Box, west end, Signal Bridge "G."
	25	12-ohm	Box, east end, Signal Bridge "H."
	23	12-ohm	Box, west end, Signal Bridge "J."
	8	12-ohm	Box, between "K" Tower and Bridge "H," 38 and 40 tracks.
	8	12-ohm	Box, between Bridges "H" and "J," 38 and 39 tracks.
	34	12-ohm	Relay room, "K" Tower.
	55	150-ohm	" " " "
	157	1 000-ohm	" " " " (4-point).
	31	1 000-ohm	" " " " (2-point, high voltage).
Massachusetts Avenue, or "A" Tower.	12	12-ohm	Relay-room, "A" Tower
	12	150-ohm	" " " "
	30	1 000-ohm	" " " "
	29	1 000-ohm	Battery-room, "A" Tower.
	14	12-ohm	Relay-box, First Street Tunnel.
	46	1 000-ohm	" " " " "

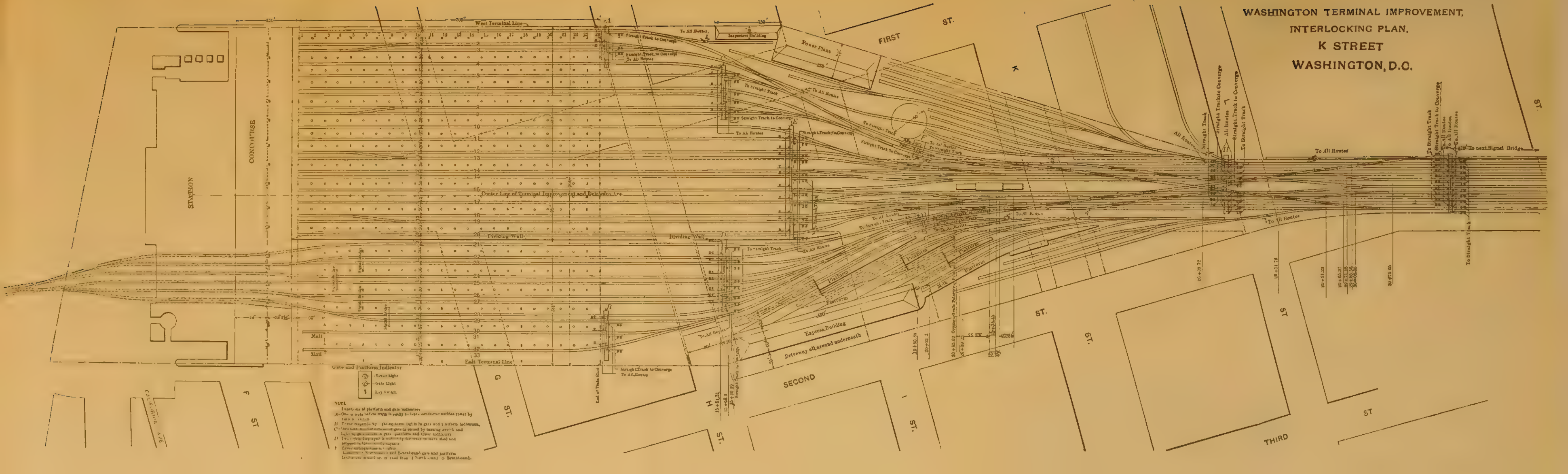
The signals are lighted by electricity, one 2-c.p., 110-volt lamp being used for each signal. The lights on each side of each interlocking are controlled by a fused knife-switch on the switch-board in each tower. There is also a fused knife-switch at each signal bridge. The branch wires leading up the signal poles are encased in loricated pipe. Cast-iron junction boxes, containing binding posts mounted on slate slabs, are used at the junctions of the loricated pipes.

The mechanism for operating the three-position signals consists of two vertical cylinders, the compressed air being admitted and released by the standard electro-pneumatic magnet and valve. Each cylinder operates a rack in a suitable guide, the racks in each pair of cylinders facing each other. Between the two racks there is a floating pinion, to which the rod for operating the blade is attached. This method of operating the three-position upper-quadrant signals was first applied on this work, and is a marked improvement in the mechanism for controlling signals of this style.

The intercommunication system of push-buttons and semaphore indicators in the towers and wire connections between them is for the purpose of announcing the movements of trains by push-buttons. This system, in addition to announcing the movements, gives information as to the class, destination, and routing of trains and equipment, and facilitates prompt disposition after they have been announced. The system is much quicker than telephone or telegraph, and equally sure. The apparatus consists of 272 semaphore indicators, 288 push-buttons, and 29 train describers. The wire used in the system is a standard, lead-covered, telephone cable, containing 160 No. 19 B. & S. gauge wires.

The train-starting system, providing for communication between train conductors, gatemen at the concourse, and tower directors, is quite novel. It is the first of its kind to be installed, and consists of light signals controlled by the above employees. At intervals of 180 ft. along each platform, in the columns supporting the train shed, there are light boxes consisting of two separate lenses behind which there are electric lamps normally dark, and a circuit controller operated by a key similar to a latch key. This method of control instead of a push-button device was adopted in order to prevent unauthorized persons from tampering with the system. At each platform gate there are two lamps, normally dark, enclosed by opalescent globes, and supported on brackets attached to the gate post opposite that in front of which the gateman stands while examining tickets and directing passengers to the trains. In K Street and Massachusetts Avenue towers there are aluminum cabinets each containing three lamps, normally dark, for each track over which each tower exercises control. The cabinet in K

PLATE CXX.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
STROUSE ON
THE WASHINGTON TERMINAL STATION.



WASHINGTON TERMINAL IMPROVEMENT, INTERLOCKING PLAN, K STREET WASHINGTON, D.C.

Street tower contains 33 sets, or a set for each track in the train yard; the cabinet at Massachusetts Avenue tower has 9, for controlling the movements on the nine low-level tracks connecting with the tunnel.

About one minute before his train is due to leave, the conductor inserts his key in the bottom of the light box facing the track upon which his train stands and operates the circuit controller, lighting one of the three lights in the cabinet in the tower. The train director arranges the route and when ready presses a button in the cabinet, extinguishing the light therein and at the same time lighting another light in the cabinet and one in each of the columns and one at the concourse gate. When the time arrives for the departure of the train, the gateman closes the gate and operates a switch in a cabinet near by, which lights a second light in the columns and at the gate, and the third light in the tower. This gives the conductor the signal to move his train out of the shed to the interlocking signals, from which point the movements are governed in the usual manner. After the train leaves the shed, the lights are extinguished by the train director.

The compressed air for the operation of the switches and signals throughout the system is furnished by the Nordberg compressors in the power-house at First and I Streets, N. E. It is conveyed to the different functions through 2-in. galvanized-iron pipe at a pressure of from 80 to 90 lb., the complete system embracing two lines of 2-in. pipe extending from Massachusetts Avenue to New York Avenue. Connections between the two lines are made by carrying the cross-connections over the bridges. With a proper system of valves, it is possible to operate the entire layout from one line, leaving the other line accessible for repairs. Normally, however, both lines are in service. Before going into the system, the air is passed through an atmospheric after-cooler near the power-house; this cools and dries the air, in order that moisture may not freeze in the valves. The current for charging storage batteries and lighting signals is also obtained from the power-house, where it is generated by the Westinghouse-Parsons turbo-generators.

This signal scheme is the result of the combined ideas of the Signal Departments of the Baltimore and Ohio and the Pennsylvania Railroads; the principles carried out embody the best of each, the standards being those in use on both roads.

In this layout 3 000 000 ft. of insulated copper wire and 23 000 ft. of 2-in. galvanized-iron pipe were used, or the equivalent of nearly 570 miles of single conductor and 4½ miles of iron pipe.

The track arrangement covered by the New York Avenue interlocking plant consists of four double-track main lines, two operated by the Baltimore and Ohio Railroad, one by the Philadelphia, Baltimore, and Washington Railroad, and one by the Washington Terminal Company as equipment tracks between the station and the shops, together with two switching tracks, one on each side of the eight tracks above mentioned. The layout comprises 14 double slip-switches with movable-point frogs, and 7 single switches.

The K Street plant, at the throat of the train yard, controls the switches and signals of the track layout, permitting movements from the extreme east or west approach tracks to the opposite extreme tracks in the train yard. Normally, eight in or out movements can be made simultaneously to the high-level tracks and two to the low-level. This plant operates 27 double slip-switches with movable-point frogs, 58 single switches, and 3 derails, with the corresponding signals.

The track arrangement at Massachusetts Avenue is quite simple. At this point nine tracks merge into two tracks leading south through the twin tunnel under Capitol Hill to a connection with the main tracks of the Philadelphia, Baltimore, and Washington Railroad on Virginia Avenue. This is accomplished by the use of two double slip-switches with movable-point frogs, seven single switches, and one fixed crossing, the latter permitting movements to the extreme sides of the train yards from either tunnel track.

The points of special interest in this interlocking layout are the use of the three-position speed signals, involving the upper-quadrant principle of operation; the use of electric detector circuits for locking the switch levers, in lieu of detector bars; the illuminated track diagrams; the intercommunication system; the train-starting signal system; and the use of electricity for lighting the signals.

The Union Switch and Signal Company originated the upper-quadrant principle and the electric detector circuits, the first use of the former antedating the installation at Washington by about two years, the latter by a somewhat longer period.

The plants, as now completed and in service, are, no doubt, the most complete of any built to date, and are certainly a credit to the company which put them in.

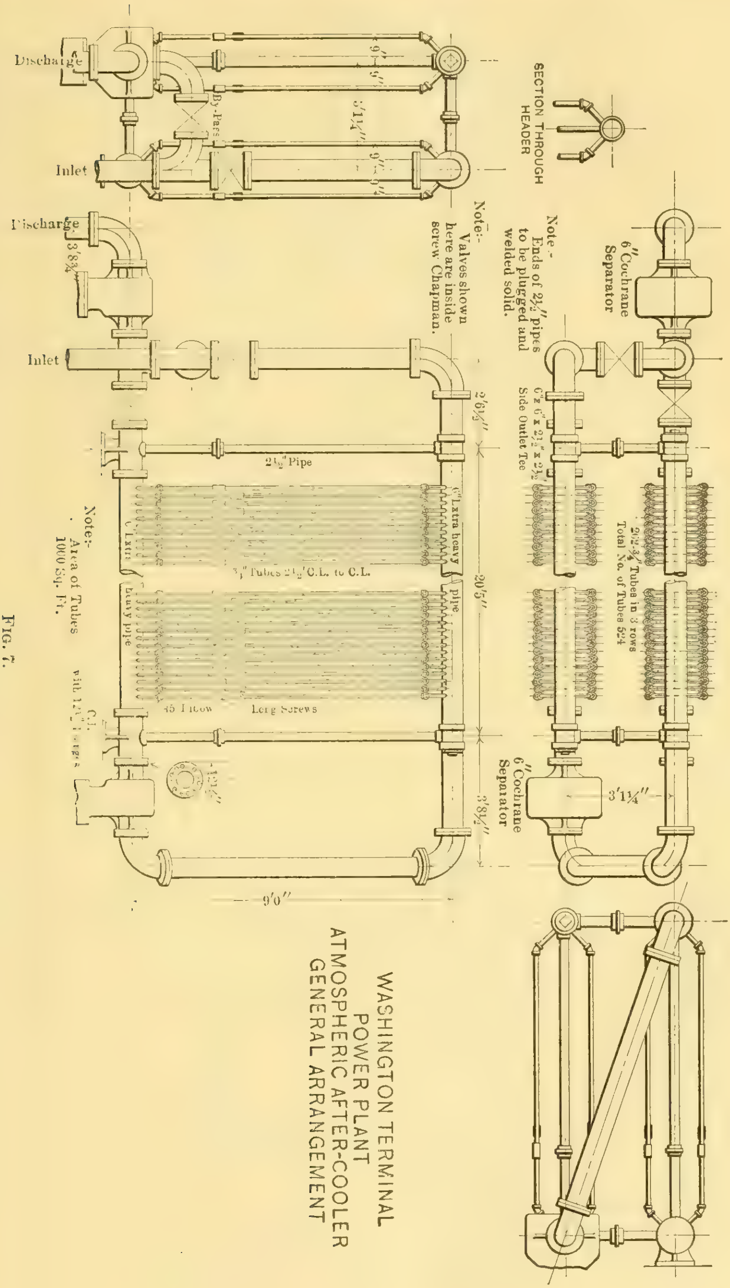

Discharge
Inlet
By-Pass
9'
3'1¼"
SECTION THROUGH HEADER
Discharge
3'8¾
Inlet
Note:-
Valves shown here are inside screw Chapman.
Note:-
Ends of 2½" pipes to be plugged and welded solid.
6" Cochrane Separator
6"x 6" x 2½" x 2½" Side Outlet Tee
2'6½"
2½" Pipe
6" Extra heavy pipe
¾" Tubes 2½" C.L. to C.L.
20'5"
2½-¾" Tubes in 3 rows
Total No. of Tubes 524
45 Elbow
Long Screws
C.I. with 1½" Flanges
12½"
6" Cochrane Separator
3'1¼"
3'8½"
9'0"
Note:-
Area of Tubes 1000 Sq. Ft.
WASHINGTON TERMINAL
POWER PLANT
ATMOSPHERIC AFTER-COOLER
GENERAL ARRANGEMENT

FIG. 7.

JOINT COACH YARD.

The joint coach yard has a capacity of about 750 cars, and is divided into two groups known as the east and west sections. In the west section of the yard there are concrete platforms, 5 ft. wide, in the spaces between the tracks, for the use of the cleaners. The tops of the platforms are at the same elevation as the tops of the rails of adjacent tracks, thus permitting trucking across the tracks at frequent intervals, at which points there are plank crossings.

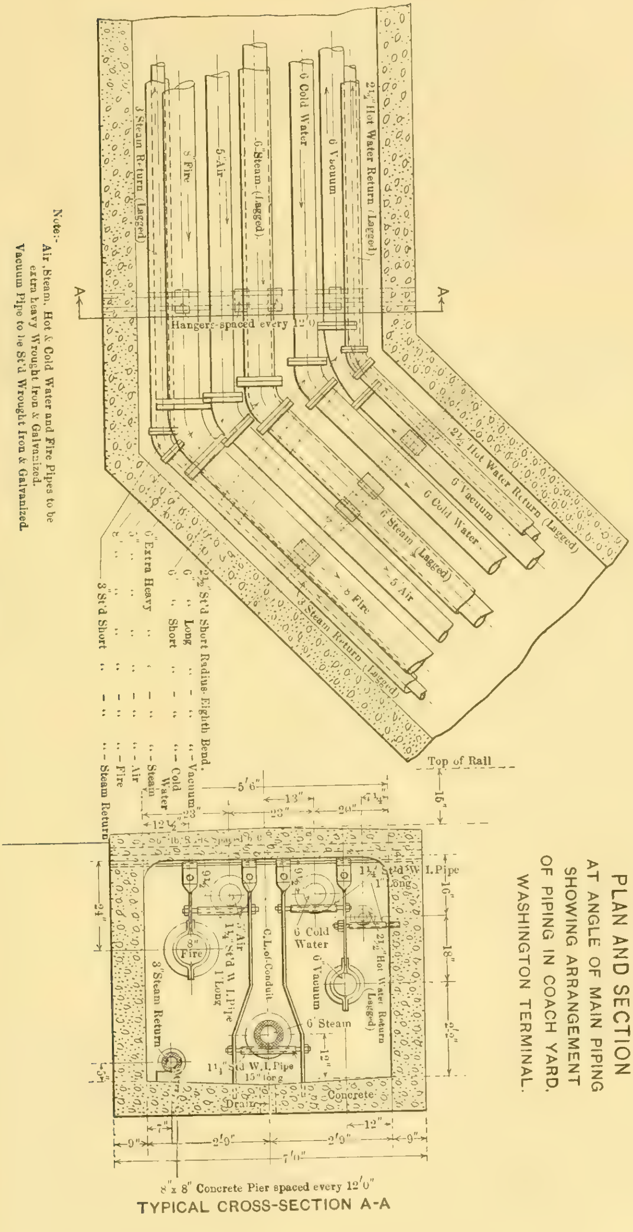
This section of the yard has a complete piping system, comprising hot and cold water, steam supply and return, air, and vacuum. The pipes are laid in concrete ducts which cross the yard, at right angles to the general direction of the tracks, at intervals of about 140 ft. Extending north and south from the power-house are reinforced concrete ducts, 5 ft. 6 in. wide and 5 ft. high, in which are the mains to which the cross-pipes are attached. No piping or platform work has been done in the east section of the yard, as it will only be used in emergencies for the storage of equipment.

A portion of the west section of the yard has been piped and wired for charging storage batteries on cars while standing on the cleaning tracks, and provision has been made for future extension of the system to other portions of the yard when needed. It has also been provided with a cleaners' building, a battery-charging station, an oil house, a kindling-wood bin, a charcoal storage building, three bedding sheds, a carpet-cleaning shed, and a power-plant along the east side.

The cleaners' building is a four-story steel and masonry structure, 50 ft. wide and 200 ft. long, with a 10-ft. cement platform along its east and west sides and its south end. It has two standard electric freight elevators, with platforms 8 ft. square, which travel from the first to the fourth floor, a distance of about 37 ft. The capacity of these elevators is 5 000 lb. at a speed of 60 ft. per min. They are operated by 110-volt, direct-current motors.

The battery-charging station is a 40 by 96-ft. brick building, with concrete and composition roof. It is divided into a generator-room and a battery-room. The former is equipped with three 50-kw. motor-generator sets, with switch-boards; the latter with the necessary racks, etc., for caring for batteries.

The oil house is a 20 by 50-ft. brick and concrete structure, and is used principally for the storage of oil used by the cleaners, the supply



Note:- Air, Steam, Hot & Cold Water and Fire Pipes to be extra heavy Wrought Iron & Galvanized. Vacuum Pipe to be St'd Wrought Iron & Galvanized.

TYPICAL CROSS-SECTION A-A

PLAN AND SECTION
AT ANGLE OF MAIN PIPING
SHOWING ARRANGEMENT
OF PIPING IN COACH YARD.
WASHINGTON TERMINAL.

FIG. 8.

being obtained as needed from the main oil house at the shops. In the charcoal storage building, a 20 by 32-ft. brick structure, is stored the charcoal to be used on private and dining cars, etc. Kindling wood, for the use of private and dining cars, etc., is stored in an 8 by 60-ft. frame bin.

The bedding sheds, 300 ft. long and about 13 ft. wide, are between the tracks, spaced at 25-ft. centers, on the extreme west side of the yard. The carpet-cleaning shed, 25 ft. wide and 62 ft. long, is on the north side of T Street bridge, immediately north of the cleaners' building.

A power-plant, 65 by 96 ft., occupies a space between the east and west sections of the yard. It comprises boiler- and engine-rooms, and was designed and equipped to furnish steam heat, hot water, air for testing brakes on cars, hydraulic pressure for fire protection, and power for operating a vacuum cleaning system. It has five 250-h.p. Babcock and Wilcox water-tube boilers, arranged for grouping in batteries of two each, the above equipment forming two and one-half batteries; the walls and foundations are built for one additional boiler, to complete the other battery when needed. These boilers have a total heating surface of 13 330 sq. ft., or about 2 660 sq. ft. to each boiler, and have Roney stokers, and the necessary engine, gears, etc., furnished by the Westinghouse Machine Company. Each stoker has a grate area of 51.3 sq. ft., approximately 1 sq. ft. of grate area for every 50 ft. of boiler heating surface, and ⅕ sq. ft. for each horse power.

In connection with the Babcock and Wilcox boilers, there are five Patterson, graduated scale-beam, hydraulic, damper regulators, carrying steam pressure up to 150 lb. and having rigid connections with one main damper, to control the draft and steam pressure.

The Warren Webster Company furnished a Webster, "Starr," vacuum, feed-water heater, guaranteed to heat 50 000 lb. of feed-water per hour from 40° to 200-210° Fahr. when supplied with the proper amount of steam at atmospheric pressure. This heater consists of a cast-iron receptacle in which cold water and exhaust steam are brought into contact. It is sealed against the admission of air (hence the term vacuum) and has twelve perforated copper trays, each 13½ by 46 in., or a total tray surface of about 50 sq. ft.

The cold water is admitted at the highest point of the heater shell through an automatic regulating valve, and passes into a sealed trough with extended lip, from which it flows in an even sheet on the perforated trays. From this point, after passing from tray to tray, it falls to a settling chamber, where a uniform level is maintained by a copper sink-pan or float. In passing through the filter the impurities fall by gravity to the bottom, while the hot water passes through the hot-water outlet chamber from which it flows to the boiler-feed pump.

The diameter of the steam inlet is 12 in.; cold-water inlet, 2½ in.; hot-water outlet, 6 in.; overflow outlet, 4 in.; and drain, 2½ in. The overflow carries off automatically any excess water, and the impurities are withdrawn through a quick-opening drain valve.

The Ingersoll-Rand Company furnished and erected a cross-compound, Corliss, engine-driven compressor, having a capacity of 1 000 cu. ft. of free air per min. The steam cylinders are 14 and 24 in. in diameter; the air cylinders are 12 and 21 in. in diameter, with a common stroke of 30 in. It is designed to operate at 85 rev. per min. under a steam pressure of 150 lb. per sq. in. against a pressure of 120 lb. When operating under these conditions the steam consumption should not exceed 20 lb. per i.h.p. per hour. The inter-cooler is of the horizontal, steel-body type. It is composed of galvanized-iron tubes through which water passes and presents a cooling surface of 300 sq. ft. to the air which circulates about them. Cross baffle-plates are placed so as to bring the air in contact with the cooling surface repeatedly, the surface being sufficient to reduce the temperature of the air to within 10° or 15° of the temperature of the cooling water.

The Laidlaw-Dunn-Gordon Company furnished a cross-compound, two-stage, Corliss, engine-driven compressor, having a capacity of 1 000 cu. ft. of air per min. The steam cylinders are 14 and 25 in. in diameter, the air cylinders 13 and 23 in., with a common stroke of 24 in. The diameter of the steam-supply connection is 3½ in., and the exhaust 7 in. The diameter of the air-suction connection is 7 in., and the discharge 4 in. It is designed to operate with a steam pressure of 150 lb., non-condensing, at a speed of 88 rev. per min., against a pressure of 120 lb. This compressor has an overhead inter-cooler of the three-pass, counter-current type, admitting air to the cooler shell through the port running around the cooler at the top of the shell, the air traversing the entire length of the cooler three times and discharging at the bottom. It has 234 ⅝-in. brass tubes, divided off by two horizontal baffle-plates. The tubes are 8 ft. 2½ in. long, and present a cooling surface of 300 sq. ft. When operating under normal conditions the steam consumption is guaranteed not to exceed 21 lb. per i.h.p. per hour.

The M. W. Kellogg Company, of New York, built the chimney for this power-house. It has a height of 150 ft. above the foundation, an inside diameter of 8 ft. 4 in., and a flue opening 4 ft. 11 in. wide and 11 ft. high. It is circular in cross-section from foundation to top, and divided into nine sections, eight of 16 ft. 6 in. and one of 18 ft. It is constructed of improved, perforated, radial blocks with corrugated sides, and made of hard-burned refractory clay.

The blocks were laid up in mortar consisting of 1 part Portland cement, 2 parts fresh-burned lump lime and 4 parts clean sharp sand. In preparing the mortar the sand and lime paste were mixed in the usual manner; the cement was then added in small quantities as the mortar was required. The foundation was constructed by the building contractor.

The stack is lined with 4-in. fire-brick to a height of 68 ft., the lining being divided into sections supported on corbels formed in the chimney walls. It is separated from the main brickwork by a 2-in. air space. The clean-out door, 2 ft. wide and 3 ft. high, is hinged to a cast-iron frame, built into and secured to the brickwork, in the base of the chimney. At intervals of about 18 in. on both the inside and outside of the stack, there are $\frac{5}{8}$-in., round, galvanized-iron step-irons which form a ladder extending from a point about 3 ft. above the foundation to the top.

The chimney is guaranteed to withstand a wind pressure of 50 lb. per sq. ft., and the action of gases and heat from combustion of 800° Fahr., for a period of five years from the date of completion. It is protected against lightning by an Ajax lightning conductor.

The Vacuum Cleaner Company, of New York, installed a cleaning system consisting of two 10 by 24 by 18-in. single, fork-frame, horizontal, steam-driven, vacuum pumps, built by the Clayton Air Compressor Company, designed to operate at 120 rev. per min., each having a displacement of 1 133 cu. ft. of air per min. The steam consumption is guaranteed not to exceed 30 lb. per i.h.p. per hour, with a steam pressure of 150 lb.

The pumps are connected so that one or both can be operated, as conditions require. Two separators, each 84 by 42 in., were furnished, one dry, the other wet. The plant is designed to operate twenty 12-in. renovators at one time. To make the plant available for cleaning coaches, there is a system of piping, with necessary connections, over the entire west half of the yard. All pipe is of heavy, galvanized, wrought-iron, with galvanized, cast-iron, recessed, long-sweep elbows, **T**'s, and **Y**'s. The sizes of the main-line pipe are 2, 3, 4, 5, 6, and 8 in., with branches 2, 3, and 4 in. The main pipes have plugged outlets for future extension to the east portion of the yard. The main line has three cut-off valves, so as to permit repairing certain portions of the line without cutting out the entire system. The equipment also contains 2 000 ft. of Voorhees, non-collapsible hose, in 50-ft. lengths, 20 1 by 12-in. carpet renovators, 10 1 by 8-in. bare-floor renovators, 20 1 by 8-in. wall brushes, 20 1 by 6-in. cushion renovators, 20 1 by 4-in. hand renovators for curtains and car seats, 20 1 by 4-in. round-brush renovators, and 10 sets of extension tubes with observation glasses.

Two 12 by 7¼ by 12-in. boiler feed-pumps were furnished by the Platt Iron Works; two 10 by 6 by 10-in. circulating pumps and two 16 by 9 by 12-in., underwriter, 750-gal., fire pumps were furnished by the Blake and Knowles Steam Pump Works, and, for use in connection with the hot-water supply in the coach yard, the Chesapeake Machine Company furnished two tanks, 6 by 23½ ft., each having a capacity of about 5 000 gal.

JOINT ENGINE YARD.

The shop and engine yard is east of the coach yard, and consists of engine-storage tracks, car-repair tracks with drop-pit facilities, coal and ashes storage tracks, and the tracks used in connection with the cinder and inspection pits, the coaling station and sand-house, and the roundhouses.

The shop buildings and facilities consist of two 25-stall roundhouses, a car-repair shop, a machine and blacksmith shop, a storehouse, a power-house, an enginemen's building, an oil-house, two ash-pits, two locomotive-pits, two steel water-tanks, a coaling station, a sand-house, drop-pits in the repair yard, casting platforms and sheds, and a telpherage system at the west end of the machine and car-repair shops for handling heavy castings.

The roundhouses are brick buildings with slag roofs, 94 ft. 3 in. between the inner and outer walls, each stall being 14 ft. 3¼ in. wide at the inner and 26 ft. 1½ in. wide at the outer end. There are engine-pits in every stall, and drop-pits in certain stalls of the north house. The buildings are heated by steam, large radiators being placed against the outer wall of each stall. The entrances to the stalls have Wilson, wood-slat, rolling doors, and the outer walls contain large windows, furnishing ample light.

The car-repair shop is a 66 by 146-ft. brick building, with a slag roof supported on steel trusses. Skylights in the roof provide ample light. The floor space is divided into three rooms, one used as a lavatory and locker room, the other two as car-repair and wheel and axle machine shops.

The machine and blacksmith shop is an 80 by 145-ft. brick structure, with a slag roof. It is divided into two sections, one used as a blacksmith shop, the other as a machine shop. The machine shop is divided into three bays by the two lines of columns which support the roof, and a runway for a traveling crane. There is a small office and tool-room in one corner.

The storehouse, 66 by 115 ft., has a 20-ft. platform along the north side. The exterior walls are of brick, and the roof is of reinforced concrete supported on steel columns encased in concrete. This construction was adopted in order to make the structure fire-proof. There is a storekeeper's office in one corner; the remainder of the room is filled with racks and shelving for the storage of supplies.

The power-house is a 41 by 117-ft. brick building, divided into three sections. The west section contains the boilers, boiler feed-pumps, feed-water heater, and the vacuum pump on the heating system. The middle section contains the air compressor, boiler wash-out pump, two fire-pumps, and one after-cooler. The east section is used as an electric sub-station, and contains three static transformers and three motor-generator sets, with the necessary switch-boards, etc.

An 80 by 130-ft. casting platform occupies the space between the blacksmith shop and the storehouse. There is a small frame structure on this platform, in which bar and sheet iron are stored. The remainder of the area with its contents is exposed to the elements.

The enginemen's building is a 60 by 116-ft., two-story, brick structure, with Ludowici tile roof. The first floor contains offices, a lounging-room, mess-room, locker-room, lavatory, and toilet-room. The second floor contains the master mechanic's office, and sleeping apartments for the engine crews. Accommodations are provided for about 50 men.

The oil-house is a 30 by 88-ft. brick and reinforced concrete building of fire-proof construction, and consists of a main floor and basement. The oil-storage tanks are in the basement from which there are pipes to the main floor where they are connected with a system of measuring pumps. The entire equipment was furnished and put in by S. F. Bowser and Company, of Fort Wayne, Ind.

There are two double-track ash-pits, 156 ft. long, of the depressed type, one on either side of the approach to the coal wharf and sand-house. The engine tracks are at 24-ft. centers, and are supported on reinforced concrete foundations and walls arranged so as to provide space for the depressed track. Each pit can accommodate four engines. The engine tracks are level throughout the yard. The cinder tracks leading to the bottom of the pits are on a 5% grade.

Each ash-pit has its double-track locomotive inspection pits of concrete. Each pit can accommodate two engines, the two pits forming a group connected by a subway beneath the tracks. Entrance to the pits is effected by a stairway between the tracks, thus eliminating the element of danger to inspectors. These pits are connected with the foreman's office by a pneumatic tube system put in by the Miles Pneumatic Tube Company.

The coaling station, including the approach, is of steel; the sand-house is of steel frame and reinforced concrete. The coal wharf proper is double-track, 161 ft. long, and has storage pockets with measuring devices operated by compressed air. The approach is single-track on a 5% grade.

The sand-house is a double-track structure, 75 ft. long. Wet sand is stored in the space at each end, the drying-room is in the center. The dry-sand pockets are at the top of the structure on each side. The drying-room has four sand stoves, and pneumatic facilities for storing sand in the dry-sand pockets. The reinforced concrete roofs over the drying-room and the dry-sand pockets were water-proofed by plastering them with a mortar containing Medusa Compound, and up to the present time good results have been obtained.

The water tanks are 24 ft. in diameter and 50 ft. high, each tank having a capacity of about 160 000 gal. They receive their supply from the 12-in. main in the yard by 10-in. connections. The discharge outlets are 12 in. in diameter, and connect with a 16-in. main leading to the penstocks near the coaling station. To provide for contingencies, a direct connection has been made between the city supply and the 16-in. penstock main. Owing to the high pressure in the city mains, this connection will only be used in emergency.

The equipment in the power-plant was designed to supply steam heat in the shop buildings, compressed air in the roundhouses, repair yard, and at the coal pockets, fire protection for the shops and repair yard, and for transforming the electric current supplied by the main power-plant to suit the voltage of the several machines in the shops operated electrically.

The Babcock and Wilcox Company furnished and erected three 250-h.p., water-tube boilers, arranged for grouping in batteries of two each, the above equipment forming one and one-half batteries, with foundations and walls arranged for an additional boiler to complete the second battery when needed. Each has a heating surface of about 2 660 sq. ft., a grate area of 51.3 sq. ft., and has Roney stokers. The complete stoker equipment was furnished and erected by the Westinghouse Machine Company.

The George A. Blake Manufacturing Company furnished two 10 by 6 by 10-in., duplex, outside, end-packed plunger, pressure-pattern, boiler-feed pumps. Two 16 by 9 by 12-in., 750-gal., standard, underwriter, fire pumps, and one 12 by 10 by 12-in. duplex, piston-packed, brass-lined, boiler wash-out pump, of the Smith-Vaile type, were furnished by the Platt Iron Works.

The Harrison Safety Boiler Works furnished a 28-B, Cochrane, feed-water heater capable of raising the temperature of 30 000 lb. of feed-water from 60° to 212° Fahr. per hour. It is 42 in. square, 90 in. high, contains 20 21 by 15-in. trays, and has a filter bed 42 in. square and 14 in. deep. The exhaust inlet and outlet are 14 in. in diameter; the cold-water supply, 2½ in.; the pump suction, 5 in.; and the returns, 5 in. The construction and operation are similar to those in the main power-house.

The Nordberg Manufacturing Company furnished and erected on foundations provided by the Terminal Company a cross-compound, non-condensing, Nordberg-Corliss, two-stage, air compressor, complete, ready for steam, air, and exhaust connections. The steam cylinders are 15 and 26 in. in diameter, and the air cylinders 14½ and 25 in., with a common stroke of 32 in. When operating at 83 rev. per min. under a steam pressure of 150 lb. per sq. in., this compressor will deliver

1 500 cu. ft. of air per min. at a pressure of 120 lb. When operating under the foregoing conditions the steam consumption will not exceed 6.6 lb. for every 100 cu. ft. of air compressed. The construction and operation of, and equipment supplied with, this compressor are similar to that in the compressors furnished by the same company for the main power-plant, and more fully described under that head.

A tubular, water-cooled after-cooler, consisting of a metal cylinder fitted with 234 1-in., seamless, drawn-brass tubes, 7 ft. 2 in. long, presenting a cooling surface of 450 sq. ft., was also furnished by the same company for drying the air before it is sent out for use in the yards and shops.

The Westinghouse Electric and Manufacturing Company furnished three 50-kw. motor-generator sets, each consisting of one 50-kw., type-S, compound-wound, 250-volt, direct-current generator, mounted on a common bed-plate and shaft with one 75-h.p., type-CCL, 2 300-volt, 3-phase, 60-cycle, induction motor. These generators have a rating of 200 amperes and 250 volts, and a speed of 690 rev. per min. Their efficiency at normal voltage and speed is 88% at half load, 90.5% at three-quarters, and 91% at full load. They are guaranteed to run for 12 hours under full load without sparking, and with no serious sparking if the load is increased 75% temporarily. The temperature of any part of the generator when operated under full load for 24 hours will not rise more than 35° cent., except the commutator, which should not exceed 40° cent. above the surrounding atmosphere of 25° cent.

The 75-h.p. motor has a frequency of 7 200 alternations per min., or 60 cycles per sec., a speed of 720 rev. per min. at no load and 690 at full load. Its efficiency is 85% at half load, 86% at three-quarters, and 86.5% at full load. The temperature changes will not exceed 40° cent. for normal conditions.

The 2 300-volt, 3-phase, 60-cycle current received from the main power-plant is converted to 220-volt, direct current by these motor generators, and at this voltage is distributed to the various machines operated by variable-speed motors. The constant-speed machines are driven by 3-phase, 60-cycle, 220-volt, induction motors, the current for which is obtained by stepping down the 2 300-volt, 3-phase, 60-cycle current through oil-cooled transformers.

The chimney for this plant was built by the Alphons Custodis Chimney Construction Company. The octagonal foundation, 20 ft. in diameter and 6 ft. deep, was built by the building contractor. The chimney proper is 125 ft. high. The base is octagonal, and extends to a height of 25 ft. with 24-in. walls of hard, well-burned, red brick; above this point the chimney is of buff perforated blocks of the Custodis pattern. It is circular in plan, and divided into six sections: five of 16 ft. 5 in., and one of 17 ft. 11 in. The walls vary in thickness from 17 in. in the first section above the base to 7½ in. at the top. The chimney is lined to a height of 60 ft. with 4-in. fire-brick, the lining being divided into sections corresponding to those of the outer wall. There is a 2-in. air space between the walls. The flue opening is 4 ft. 8 in. wide and 8 ft. 2 in. high, strengthened at the top and bottom by 6-in. I-beams built into the brickwork.

Of the foregoing structures, the cleaners' building, the coach yard oil-house, the bedding sheds, the carpet-cleaning shed, and the coach yard power-house were erected by Edward Brady and Son, of Baltimore, Md., the other buildings by Wells Brothers Company, of New York City.

Shop Machinery and Tools.—Table 5 is a list of the machinery and tools in the machine and blacksmith shop and in the car-repair shop, all of which are operated by 220-volt alternating- or direct-current motors. The machines operating at constant speed have 3-phase, 60-cycle, 220-volt, induction motors, those operating at variable speeds have 220-volt, direct-current motors.

General Grading and Masonry.

The contract covering the grading, masonry, and drainage of the north approach to the Union Station was let to the McMullen and McDermott and the Hoffman Engineering and Contracting Company, joint contractors, of Philadelphia, Pa., on July 21st, 1903. The grading aggregated more than 3 000 000 cu. yd., the masonry more than 160 000 cu. yd., foundation excavation more than 186 000 cu. yd., and nearly 1 900 tons of iron pipe were used for drainage.

The greater part of the excavation was in the coach-yard section, the average depth of cut over a large area being about 50 ft., with a maximum of 82 ft. In one cut in the heart of the coach yard, there were about 2 250 000 cu. yd. This material was excavated by 70-ton steam shovels, and moved by narrow-gauge dump-cars, of 4 cu. yd. capacity, and narrow-gauge Baldwin locomotives. A portion of the material was utilized in forming the roadbed between the retaining walls on the approach and train-yard sections, for filling in and around the station foundations and walls, in forming the plaza in front of the station, and in filling the streets leading to it; the remainder was wasted wherever waste banks could be secured. Approximately half of the excavated material was utilized by the Terminal Company; the other half was moved as an expense. In disposing of the material, the average haul was about 1½ miles.

TABLE 5.—MACHINERY AND TOOLS IN MACHINE AND BLACKSMITH SHOP AND CAR-REPAIR SHOP.

Machine.	Size.	Make.	Motors.
MACHINE AND BLACKSMITH SHOP.			
4 Engine lathes	16-in. by 6-ft	Lodge & Shipley	D. C.
1 Engine lathe	20-in. by 12-ft	Lodge & Shipley	D. C.
1 Engine lathe	27-in. by 16-ft	Lodge & Shipley	D. C.
1 Engine lathe	36-in. by 16-ft	Lodge & Shipley	D. C.
1 Turret-head bolt-cutter	No. 4	Pratt & Whitney	D. C.
1 Radial drill	36-in	Bickford	D. C.
1 Full Universal drill	60-in	Bickford	A. C.
1 Boring mill	54-in	Bullard	A. C.
1 Double-head shaper	18-in. by 12-ft	Manning, Maxwell & Moore.	D. C.
1 Planer	36 by 36-in. by 8-ft	Pond	A. C.
1 Crank slotter	18-in	Niles-Bement-Pond	D. C.
1 Double-head bolt-cutter	1½-in	Acme	D. C.
1 Standard threading machine	3-in	Cox	D. C.
1 Single emery grinder	No. 3	Bridgeport	D. C.
1 Double emery grinder	18 and 20-in. by 2½-in	Aumen Machinery Co	D. C.
1 H. & J. Standard punch	No. 3	Manning, Maxwell & Moore.	A. C.
1 H. & J. Standard shear	No. 4	Manning, Maxwell & Moore.	A. C.
1 Steam hammer	1 500-lb	Niles-Bement-Pond	....
1 Driving-wheel lathe	90-in	Niles Bement-Pond	D. C.
1 Planer	42 by 42-in. by 10-ft	Niles-Bement-Pond	A. C.
4 Portable forges	No. 3	Buffalo	....
1 Steel pressure blower	No 4	B. F. Sturtevant & Co	D. C.
1 Jib crane (hand-power)	7-ton	Whiting Fdry. Equip. Co	....
1 Electric traveling crane	10-ton, 3-motor	Niles-Bement-Pond	....
CAR-REPAIR SHOP.			
1 Car-wheel lathe	42-in	Niles-Bement-Pond	D. C.
1 Double-head bolt-cutter	2-in	Acme	D. C.
1 Double-axle lathe	....	Bridgeford	A. C.
1 Hydrostatic wheel-press	48-in., 300-ton	Niles-Bement-Pond	A. C.
1 Car-wheel borer	48-in., No. 2	Putnam	D. C.
1 Saw-filer and setter	....	Dietrick & Harvey	....
1 Combined gainer and mortiser	No. 512	Greenlee Bros. & Co	A. C.
1 Friezer and shaper	No. 8	Fay & Egan	A. C.
1 Smoothing and finishing planer	30-in	Bentel & Margedant	A. C.
1 Heavy band-saw	No. 311, 36-in	Smith Machine Co	A. C.
1 B. & S. grindstone	40 by 5-in	Hill, Clarke & Co	A. C.
1 Wood trimmer	No. 1	Oliver	....
1 Pattern-maker's lathe	20-in. by 9-ft	Oliver	D. C.

The grading equipment consisted of six 70-ton, steam shovels, equally divided between the Vulcan and Bucyrus types, one Thew shovel for street work, about 250 dump-cars, and 20 dinky locomotives.

The mass of the masonry was between Florida Avenue and the station, and the equipment for its construction consisted of two cubical and one Hains' concrete mixers, about 40 derricks, of the guy and stiff-leg types, of from 10 to 15 tons capacity, operated by three-drum, 7¼ by 10-in., hoisting engines, and the usual trucks and buckets for handling the various materials.

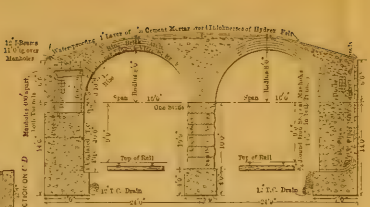
The booms of the derricks, many of which were 65 ft. long, were swung by 10-ft. bull-wheels at the bases of the masts. Most of the wheels were made of light T-rails bent to a circle; they rendered very efficient service.

The same contractors, under other contracts, executed all work in connection with the construction of the conduit system for the protection of the telephone and telegraph lines, the power lines between the power-house and the station and coach yard, and the wires used in the battery-charging layout in the coach yard, and furnished all labor and material required in the jacketing of the steelwork in the New York Avenue Bridge.

First Street Tunnel.

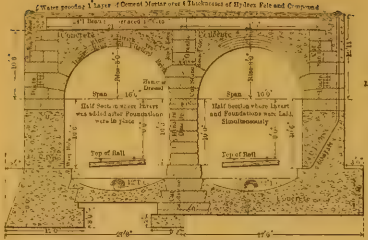
As noted elsewhere, the south approach to the Union Station is by way of a tunnel under Capitol Hill, a short section of open cut near the south portal, and an elevated structure at the connection with the Philadelphia, Baltimore, and Washington Railroad tracks on Virginia Avenue. The tunnel proper is 4 033 ft. long. Of this distance, 1 127 ft. at the south end is on a 4° 20′ curve passing under public streets and private property from First and B Streets, S. E., to the intersection of the west side of New Jersey Avenue and the south side of D Street, the remainder is on a tangent parallel to and 25 ft. west of the center line of First Street.

The approach to the tunnel, between the elevated structure over South Capitol Street and the south portal, is on a 1.5% descending grade, changing at that point to a 0.13% ascending grade through the tunnel. The depth of cut for some distance from the south end of the tunnel was barely sufficient to permit its construction below ground. At the north end, for a distance of 330 ft., the top of the tunnel is above the original surface of the street. At East Capitol Street the depth of sub-grade is 63 ft. below the surface of the street. On this account, and to facilitate ventilation, the tunnel was con-


Waterproofing 1 Layer of ½ in. Cement Mortar over 4 Thicknesses of Hydrex Felt
12" I-Beams 11'0" c. over Manholes
Span 16'0"
Span 16'0"
One Stone
Top of Rail
Top of Rail
12" T.C. Drain
12" T.C. Drain
24'0"
24'0"
SECTION ON C-D

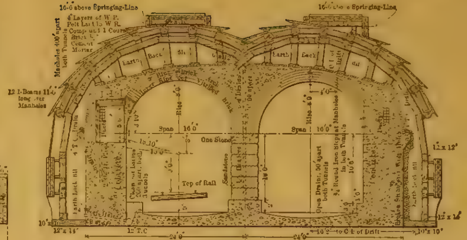
SECTION OF TUNNEL USED FROM SOUTH PORTAL TO OFFICE BL'D'G. FOR HOUSE OF REPRESENTATIVES

Note: Same section with addition of 15" invert, used between stations 53+68 and 57+28.


Water proofing 1 Layer of Cement Mortar over 4 Thicknesses of Hydrex Felt and Compound
Concrete
Concrete
Span 16'0"
Span 16'0"
Half Section where Invert was added after Foundations were in place
Half Section where Invert and Foundations were Laid Simultaneously
Top of Rail
Top of Rail
Concrete
24'6"
27'0"

REINFORCED SECTION USED UNDER OFFICE B'LD'G. FOR HOUSE OF REPRESENTATIVES.

Note.-Dimensions of stones allow for ¼" Joints.


16'6" above Springing-Line
16'6" above Springing-Line
12 I-Beams 11'4" long over Manholes
Span 16'0"
Span 16'0"
One Stone
Top of Rail
12"x12"
12"x12"
10"x10"
12" T.C.
24'0"
24'0"
10'x10"

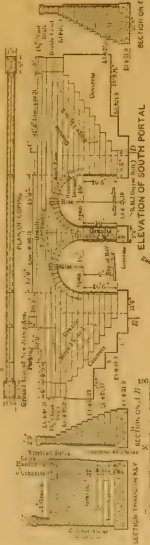
SECTION OF DRIVEN TUNNEL SHOWING TIMBER LEFT IN PLACE.

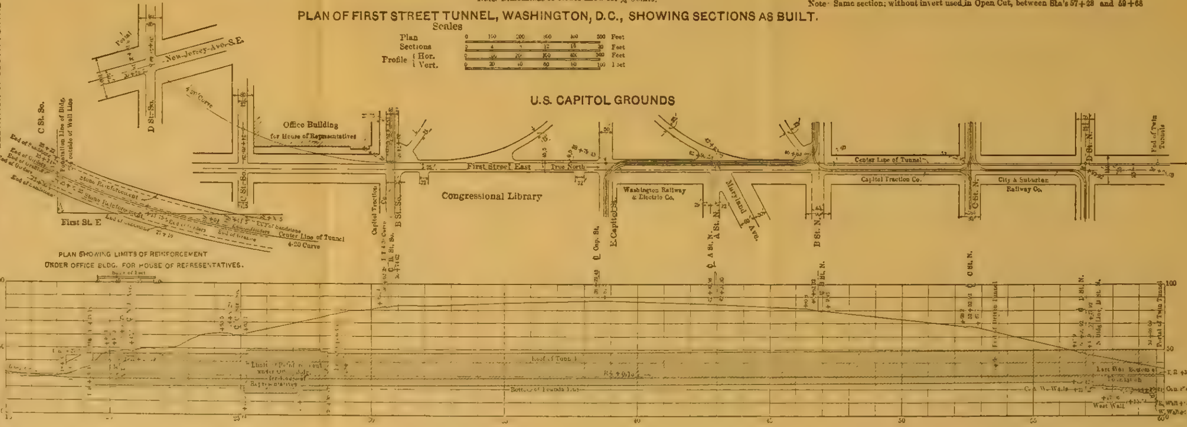
Note: Same section; without invert used in Open Cut, between Sta's 57+28 and 59+68

PLAN OF FIRST STREET TUNNEL, WASHINGTON, D.C., SHOWING SECTIONS AS BUILT.

Scales

Plan	0 100 200 300 400 500	Feet
Sections	0 4 8 12 16 20	Feet
Profile Hor.	0 100 200 300 400 500	Feet
Profile Vert.	0 20 40 60 80 100	Feet





PLAN SHOWING LIMITS OF REINFORCEMENT UNDER OFFICE BLDG. FOR HOUSE OF REPRESENTATIVES.

structed of two separate single-track tubes, side by side, the center or dividing wall being 4 ft. thick and having openings at intervals of 100 ft. to serve as refuge niches and means of communication between the tunnels. Each tube has a span of 16 ft. and a height of 17 ft. above top of rail. The center wall is of stone masonry, the side-walls and haunching of concrete, and the arches of brick.

The features of special interest in connection with this work, which are treated more or less in detail in this paper, are the methods of excavating and timbering, disposition of spoil, traveling derricks and centers used in the construction of stone, concrete, and brickwork, the facilities for storing and handling materials, and the plant for mixing concrete. Attention is especially called to the extensive use of machinery on the work, and particularly to the use of electricity and compressed air in the operation of the machinery.

The material overlying the tunnel consisted of a mixture of clay and gravel, with a layer of white sand of varying thickness at about the elevation penetrated by the tunnel. At some points it extended below sub-grade, at others it was found near the top of the tunnel. Below the sand there was a stratum of hard blue clay which in some cases extended some feet above sub-grade.

The sand and gravel overlying the blue clay contained large quantities of water, and, when the sand was thoroughly saturated, produced practically a quicksand. For the purpose of draining the soil on the drift portion of the tunnel, two 6 by 8-ft. shafts were sunk, the bottoms of which were carried well below the grade of the tunnel. One sump was about 1 800 ft., and the other 2 700 ft. from the south portal. These sumps drained the soil so that the excavation was removed with comparative ease. The water was removed from the sumps by pulsometers.

Of the total length of the tunnel, 952 ft. at the south end and 600 ft. at the north end were constructed by the cut-and-cover method. The general excavation of the cut-and-cover section was removed by a Vulcan Little Giant steam shovel operated by compressed air. This shovel operated a 1¼-yd. dipper through a vertical range of 12 ft. and a horizontal range of 16 ft.

The excavated material was deposited directly in 3-yd. wooden dump-cars on a 3-ft. gauge track, laid in a trench beside the shovel. The trains, of from 3 to 6 cars, were taken to the foot of a trestle incline by electric mine motors made by the General Electric Company. From this point they were hauled up the incline by a cable drawn by a single-drum, Lidgerwood, hoisting engine operated by a General Electric motor. At this point the material was dumped into special 20-yd., standard-gauge dump-cars owned by the contractors, and transported by the Terminal Company to waste banks and fills along Maryland and Virginia Avenues and on the approach to the Potomac River Bridge.

To maintain street traffic over the cut-and-cover section at the south end, a temporary bridge was built at the intersection with C Street in advance of the excavation. Bearings for this bridge were prepared outside the line of cut, and trenches were dug for the lower chords of the structure, so as to place the floor near the original street surfaces. A temporary footbridge, supported on bents, was constructed on the line of New Jersey Avenue. As promptly as possible after the trenches were excavated to grade at these crossings, sections of the permanent masonry were built and back-filled so as to permit the restoration of the street surface. The construction of the intervening masonry was carried on in such a manner as to conform to the logical progress of the work.

Special attention is now directed to the method of excavating the drift-tunnel. On account of the treacherous condition of the material to be penetrated, it was not considered prudent to attempt to carry on the excavation for both tubes simultaneously. Accordingly, the work on each tube was carried on independently. Side-drifts, 4 ft. 6 in. wide and 8 ft. high, with a crown-drift, 6 ft. 6 in. wide and 8 ft. 8 in. high, were first excavated and timbered for one tube, the frames being of 10 by 10-in. timber, and the lagging of 3 by 8-in. planks in 6-ft. lengths.

The headings were excavated by hand, by miners and helpers using picks and shovels. The excavated material was removed from the drifts in small cars on 20-in. gauge, industrial tracks. This work was carried on continuously throughout the 24 hours in three 8-hour shifts, about 10 ft. constituting a day's work. Following the excavation of the top drift, two crown-bars, about 12 in. in diameter and 24 ft. long, were placed in the heading and supported by posts resting on the sills of the drift-frames. Then 3-in. lagging was driven above the crown-bars into the sides of the drift, and all timber but the top of the orig-

PLATE CXXII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
STROUSE ON
THE WASHINGTON TERMINAL STATION.

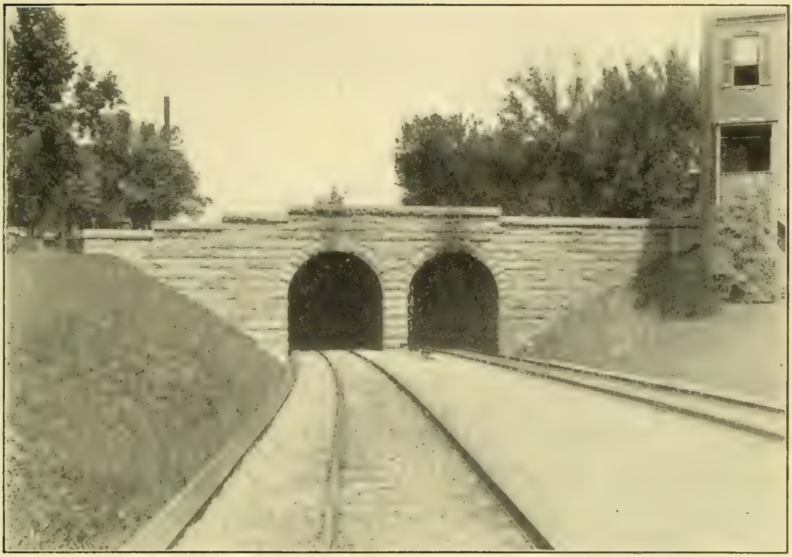


Fig. 1.—Washington Terminal Station: South Portal of First Street Tunnel.

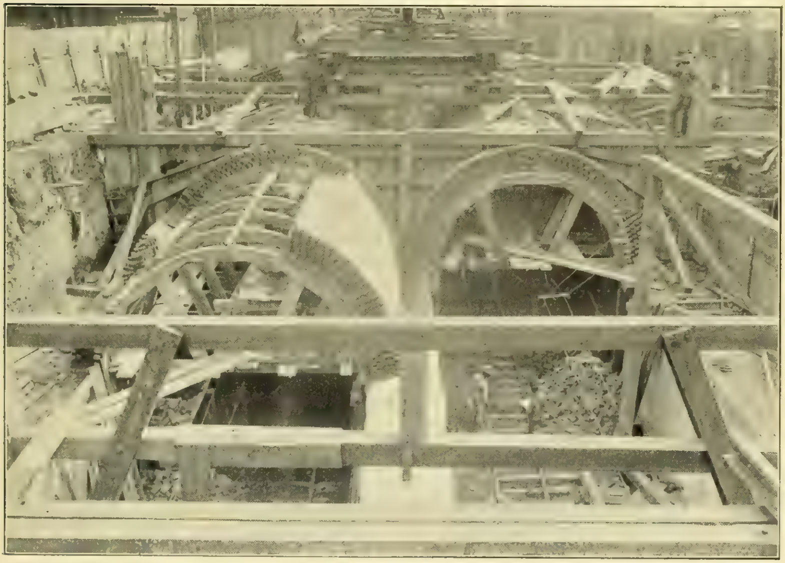


Fig. 2.—View of Construction of Arches in Open-Cut Section.

inal drift was removed. Sufficient material was then removed to provide space for two more crown-bars, which were supported on posts resting on the earth core. Lagging was again driven, and the process of excavating and timbering was continued until approximately the elevation of the springing line of the finished arch was reached. While the enlargement of the top heading was in progress, concrete footings were placed in the side-drifts in such a way as to clear the foundation lines of the permanent masonry. The posts supporting the crown-bars were then replaced by a segmental timbered arch carried down to the concrete footings in the side-drifts. The segmental timbers were 12 by 12-in. and spaced at a normal distance of 30 in. between centers, but where heavy ground was encountered they were spaced at 15-in. centers.

The core was then removed by steam shovel, and the masonry lining put in place. While the lining of the first tube was in progress, the top- and side-drifts of the other tube were being excavated, followed by the placing of crown-bars and the widening of headings as above described. The crown-bar supports were then replaced by segmental timbers, in the usual manner, except that in this case the arch timbers abutted against the concrete filling or haunching above the center-wall on one side, and the other was carried down to the concrete footing in the side-drift, as in the first instance. Following the completion of the timber arch, the core was removed, as for the first tube. The excavation of the core in the first instance covered the removal of about 23 cu. yd. per lin. ft.; in the second case about 11 cu. yd. per lin. ft. were removed.

In addition to the large drainage sumps previously mentioned, there were small sumps in the side-drifts, from which a Snow pump, operated by compressed air, forced the water through a 3-in. pipe to a large sump in the rear of the core excavation. From this point a centrifugal pump, operated by electricity, discharged the water through a 3-in. pipe to a point outside the tunnel. The pump and motor were mounted on a timber platform which permitted it to be shifted readily as the work progressed. The material in the drift-tunnel was disposed of as described under open-cut excavation.

A traveling, stiff-leg derrick with two 40-ft. booms was used for building the center- and side-walls of the open-cut work. This traveler consisted of a platform, about 20 ft. wide and 30 ft. long, resting on four wheels operating on a 16-ft. gauge track. The track was carried on a falsework of timber bents and vertical posts, utilizing as much as possible the shoring used in connection with the excavation of this portion of the tunnel. The booms were at the front corners of the platform, swung by bull-wheels, and operated by two 3-drum, Mundy, hoisting engines at the rear of the platform. As the traveler advanced in the construction of these walls, the rear bents were taken down and set up in front.

For executing similar work in the drift-tunnel, a traveler having a platform 16 ft. wide and 20 ft. long was used. This traveler operated on a 14-ft. gauge track, laid on the floor of the tunnel, and handled the ashlar and concrete for the center- and side-walls from the material cars to the workmen on the walls. The stiff-leg derricks were on the platform, as before described, but the platform was about 10 ft. above the track, leaving room for the free movement of material cars below, and the masts and booms were only about 5 ft. long. By the use of this style of derrick about 15 ft. of side- and center-walls were completed in a 10-hour shift.

This derrick operated about 100 ft. behind the steam shovel, and about 100 ft. behind it followed the arch-roof construction. For executing this work, a traveling center 20 ft. long and 16 ft. wide was used, the construction of which was similar to that of the traveling derrick, but it carried the arch ribs instead of derricks, etc. The ribs of the center were set 4 ft. apart, and were wedged from the traveler platform. By removing the wedges, the centers were moved ahead without being taken down. The lagging for the arch ribs was of 2½ by 3-in. material. A 20-ft. section of arch was built in one 10-hour shift.

After each section of arch had been completed, and before the centering was removed, the concrete backing was placed and waterproofed, and the space between the top of the masonry and the timber was back-filled with earth and tamped. The concreting and backfilling was done with a machine consisting of a platform mounted on wheels, of the same general construction as the platform of the derrick and center travelers. On the front end of this platform there was a stationary hoist, and behind it a belt conveyor. The latter was pivoted near the forward end so as to allow it to swing to the right or left on a circular track near the rear end. Near the forward end

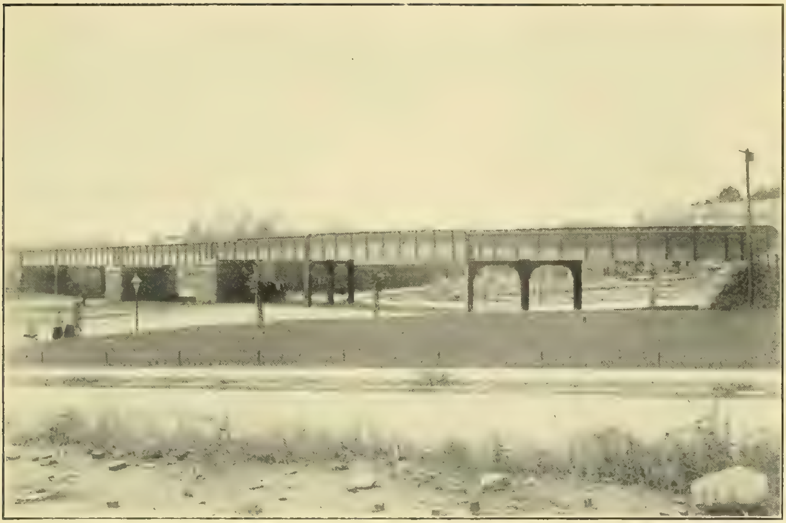


FIG. 1.—WASHINGTON TERMINAL STATION: STEEL VIADUCT OVER SOUTH CAPITOL STREET.

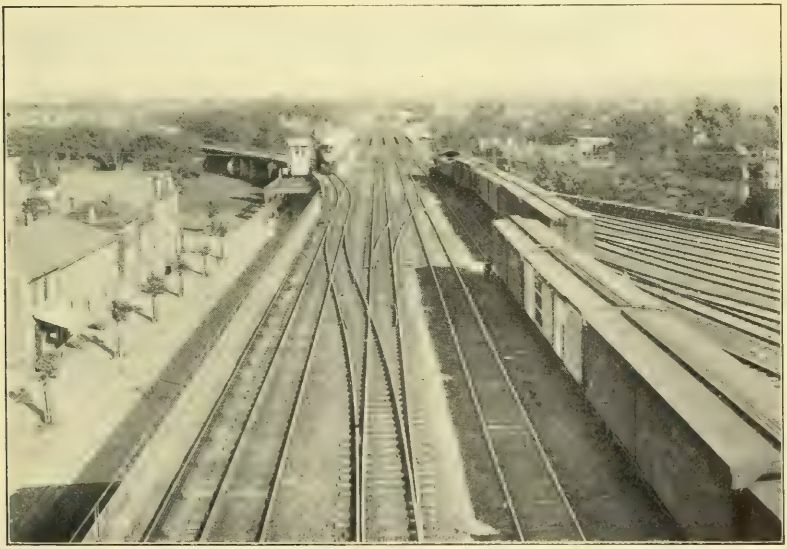


FIG. 2.—WASHINGTON TERMINAL STATION. LOOKING EAST ON VIRGINIA AVENUE.

of this conveyor there was a 30-cu. ft. hopper, from the bottom of which a belt conveyor carried the material into the space above the roof arch on a cantilever arm.

In operating this machine the material bucket was lifted from the car beneath, carried back on the trolley beam over the hopper, and there dumped by hand. From this hopper the material fell upon the belt conveyor and was carried back over the arch and deposited ready for tamping. The hoisting engine on this machine was a Lambert, driven by a 15-h.p. electric motor. The belt conveyor was 20 in. wide, and was operated at a speed of 180 ft. per min. by a 7½-h.p. electric motor. This apparatus required two men to operate it, and is estimated to have saved the labor of 12 shovelers.

The top of the finished masonry was water-proofed with four layers of Hydrex felt laid in water-proof compound. On the cut-and-cover section it was protected by 1 in. of cement mortar, on the drift section by a course of brick covered with a ½-in. coat of cement mortar. After the masonry construction for the first tube was completed and water-proofed, crown-bar supports were again introduced for the purpose of preventing settlement when the segmental timbers were cut in placing timbers in the second tube. When the masonry in the second tube was completed the crown-bars were supported as above.

As the bulk of the work had to be executed from the south end, it was considered economical to make a liberal expenditure at the outset to avoid expensive repairs and alterations as the work progressed. Therefore, electric motors were adopted for all machinery except the shovel, which was operated by compressed air. Enough duplicate motors, etc., were provided to take care of the usual break-downs, so as to avoid interruptions.

A contractors' yard was established on an irregular-shaped property near the south portal of the tunnel. On this property were the general supplies, repair shops, mechanical plant, storage yards, concrete plant, and incline hoist for handling the excavation. The tracks and structures were arranged to provide the most convenient and economical means of handling the material which the shape of the limited space would permit. The standard and narrow-gauge tracks were grouped to furnish access to the various yards and structures, as the conditions required. The yard was lighted by arc lamps distributed over the property, and, like the motors, were operated by current purchased by meter from the Potomac Light and Power Company.

Stone, lumber, and other heavy materials were handled by derricks operated by electric motors; lighter materials were moved by hand. Crushed stone, gravel, and sand were delivered at the mixing plant in dump-cars and by wagons, and after being dumped into the track hoppers were handled entirely by machinery. The cement was delivered in cars and stored in a house, the floor of which was about 4 ft. 6 in. above the top of rail of the adjacent track. The stone, gravel, and sand were discharged from the track hopper into a bucket conveyor, carried to the top of the mixer, and dumped into a hopper of about 2 cu. yd. capacity. The bottom of this hopper was fitted with an L-shaped cast-iron spout which was arranged to revolve about its vertical axis. By this arrangement material could be directed to four different chutes leading, respectively, to the trestle conveyor and the three elevated storage bins for sand, gravel, and stone.

When the materials were not needed for immediate use in the concrete mixer, the swivel spout delivered to the conveyor on the top of the storage trestle. This conveyor had a movable dumping device, which enabled it to discharge automatically into any of the storage bins beneath. At other times the swivel spout was set to deliver into the storage bins at the top of the mixing tower. As the cement was needed, the bags were carried up an incline by warehouse trucks and placed on a belt conveyor, which carried them to the floor of the mixing tower. The only hand labor then required was the untying and emptying of the sacks into the mixing hopper.

The storage trestle, 175 ft. long, consisted of a series of timber bents, about 40 ft. high, made of 8 by 8-in. posts, caps, and sills, with transverse and longitudinal bracing arranged to make alternate towers and open panels. Every other bent was boarded up, to a height of about 20 ft., to form separate bins for the various materials used for concrete and mortar. A 7 by 6-ft. timbered longitudinal trench was constructed under the storage bins throughout the entire length. It contained a belt conveyor which delivered to a cross-conveyor under the tower, which in turn delivered to a bucket conveyor near the one connecting with the track hopper. The roof of this tunnel formed part of the floor of the storage bins above. There were cast-iron scuppers, with 10 by 12-in. cast-iron gates, at intervals of

PLATE CXXIV.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
STROUSE ON
THE WASHINGTON TERMINAL STATION.

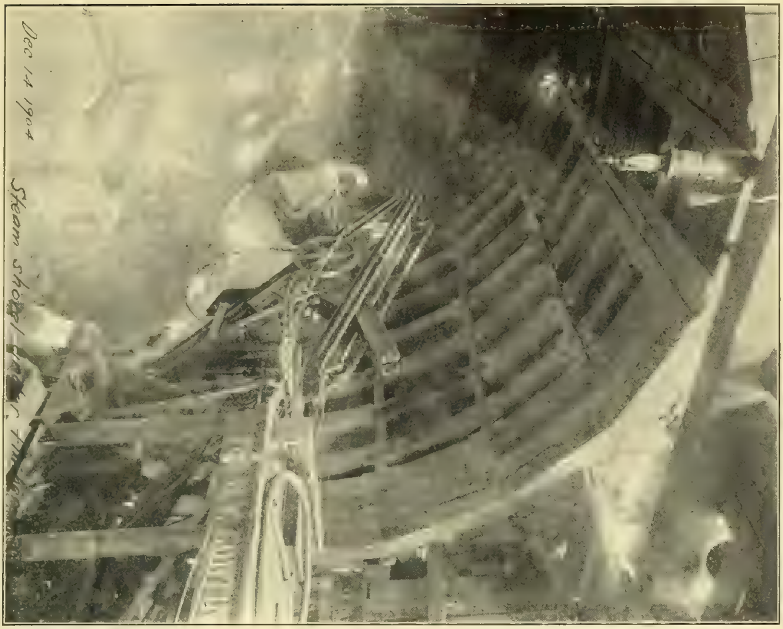


FIG. 1.—STEAM SHOVEL REMOVING CORE IN DRIFT TUNNEL, WASHINGTON TERMINAL STATION.

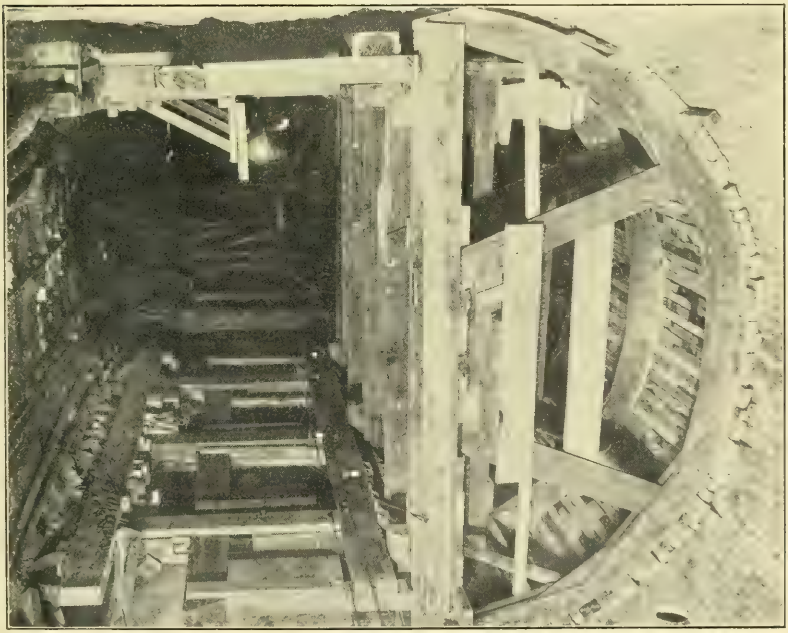


FIG. 2.—INTERIOR VIEW OF FINISHED TUBE, SHOWING TRAVELING CENTER, WASHINGTON TERMINAL STATION.

7 ft. along the center line of the tunnel over the belt conveyor. These gates were operated by hand-levers attached to racks and pinions. When materials were required from the storage piles, the scupper gates were opened, allowing the material to fall on the conveyor and be carried to the respective storage bins in the mixing tower.

The bottoms of these bins were closed by cast-iron gates operated as above. They were arranged to discharge into opposite sides of a mixing bin divided into two compartments corresponding to the different proportions of the materials used in the concrete mixture. When the compartments were filled, the gates were closed, the cement was placed on top, and the contents were dumped into a 1-cu. yd. Smith mixer by the attendant on a lower platform, who operated the hopper gates.

The water used in mixing concrete was supplied by gravity from a 500-gal. storage tank, about 5 ft. above the mixing platform, and filled from the city mains through a ball-cock. From the bottom of this tank a 4-in. pipe, controlled by a special gate-valve, led to a 200-gal. measuring tank into which it discharged through a ball-cock. It was adjusted to close when the tank contained the quantity of water requisite for a batch of concrete of a given consistency. There was also a special gate-valve on the outlet pipe from the measuring tank.

The stems of the special gate-valves were operated by separate horizontal levers, the free ends of which were connected to a vertical rod which passed through the floor of the tank-room and terminated within reach of the attendant in charge of the mixers. When the handle was pulled downward the valve on the outlet pipe of the supply tank was closed and the one on the outlet pipe of the measuring tank was opened, allowing the contents of the latter to flow into the mixer. When the handle was pushed upward it reversed the valve and permitted the tanks to fill.

The mixers were in duplicate, one was generally used for mixing concrete, the other for mortar. The chute from the mixing hopper was arranged so that one or both mixers could be used for concrete or mortar. They were dumped by hand by revolving them on their horizontal axes by a worm-gear, and discharged through an opening in the floor of the platform into 1-cu. yd. steel buckets on small flat cars. At rush times, when both mixers were used, one was being charged and mixed while the other was being discharged. In this way the capacity was doubled. Each mixer was belt-connected with a 30-h.p., 500-volt, Sprague, electric motor making 750 rev. per min. Clutches were provided for connecting the free ends of the mixer shafts when desired.

The forms for the side-wall construction were of ¼-in. steel plates, 4 ft. wide and 10 ft. high, stiffened by angle-iron flanges on all edges and by three horizontal angles across the plate, dividing the height into four equal spaces. The vertical flanges had 3½ by ¼-in. plates riveted to them and planed to make accurate joints between the several sections of the forms. The sections were joined by bolting the angle flanges together, using as many sections as might be required to cover the distance to be concreted, usually 20 ft.

The forms were braced and stiffened with a continuous line of 6 by 10-in. timbers bolted to the middle horizontal angle. The braces between this timber and the ground were set at an angle of about 45°, and spaced at intervals of about 4 ft. The lower edges of the forms were wedged and braced to the ground or by timbers carried across the cut, the top edges by horizontal struts reaching across the trench high enough to clear the motors and cars. Braces were also placed between the faces of the forms and the vertical side of the excavation, and removed as the concrete was placed.

Concrete inverts were built in the section of the open-cut work under the House of Representatives' Building, and in the entire drift-section. Drainage was provided by placing 12-in. terra cotta pipes in each tube throughout the entire length of the tunnel. Connected with these drains or with the inverts there are 4-in. drains, at intervals of 50 ft., for catching the drainage from the top of the arch and from a point near the elevation of the top of the drain. There were clean-out basins in the drift-tunnel at intervals of 200 ft. in both tubes.

Special construction was used where the tunnel passes under the office building of the House of Representatives, consisting essentially of widening and deepening the footings, the introduction of stonework in the side- and center-walls above the springing line, and reinforcing the top of the tunnel by 24-in. I-beams spaced at 18-in. centers.

In addition to the plant already described, the contractors had one steam locomotive, twelve 20-cu. yd. special dump-cars built by the

PLATE CXXV.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
STROUSE ON
THE WASHINGTON TERMINAL STATION.

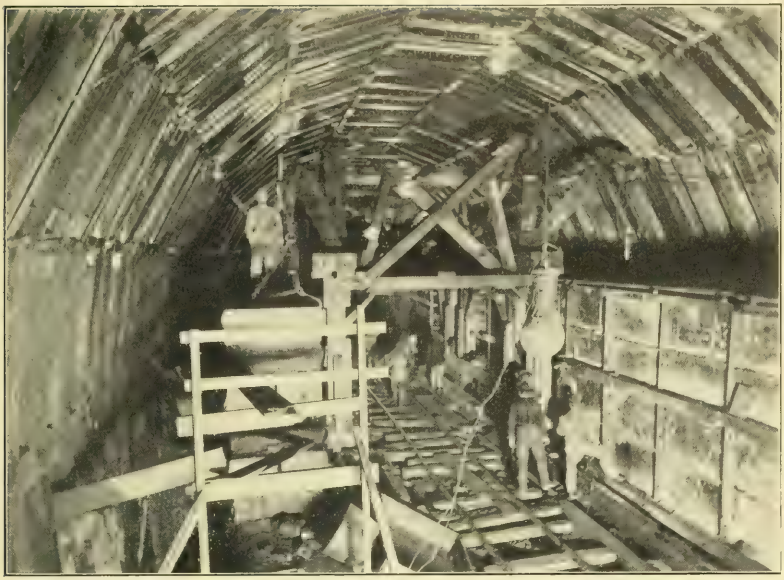


Fig. 1.—Washington Terminal Station: Traveling Derrick Used in Construction of Side- and Center-Walls.

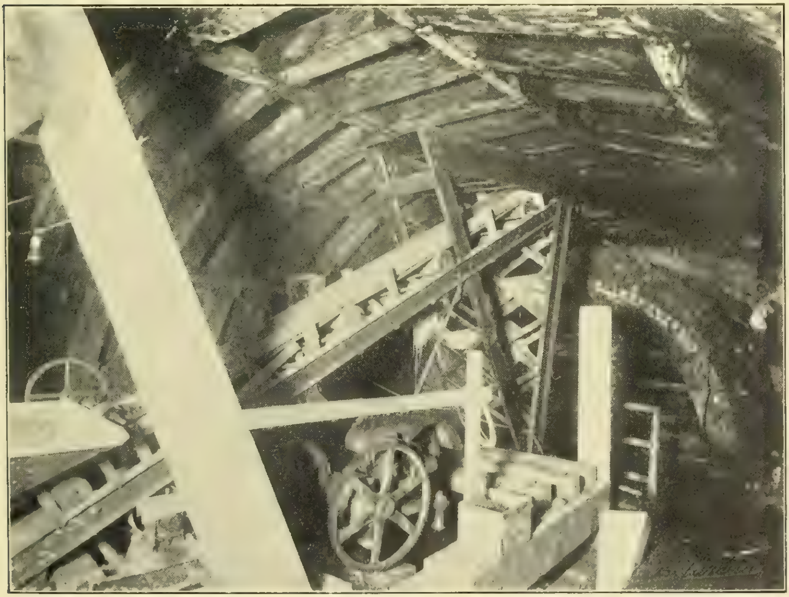


Fig. 2.—Conveyor Used in Filling Over Top of Arches in Drift-Tunnel, Washington Terminal Station.

Georgia Car Company, eight Ryan and McDonald, 3-cu. yd., wooden, side-dump-cars, ten 2-cu. yd., wooden dump-cars, four stiff-leg derricks in the storage yard, five Mundy, double-drum hoisting engines, operated by Westinghouse electric motors, two electric mine motors, and the usual small tools.

The foregoing work was executed by the New York Continental Jewell Filtration Company, under a contract dated December 10th, 1903. The excavation for the open-cut work was begun on December 6th, 1903, and the drift-tunnel on October 11th, 1904. The west tube of the tunnel was completed on May 10th, 1906, the east tube on September 6th, 1906.

BELL-MOUTH.

The construction between the north end of the twin tunnels, 275 ft. north of the center line of D Street, and the face of the station, consists of a girder-covered bell-mouth, about 525 ft. long, and ranging in width from 36 ft. at the junction with the tunnels to 116 ft. 6 in. at the south line of the station. The roof consists of 30-in. transverse girders at intervals of 20 ft., between which there are framed 20-in. I-beams, at 3-ft. centers, covered with $\frac{3}{8}$-in. steel buckle-plates.

This construction is supported on the masonry side-walls defining the limits of the bell-mouth and on masonry pedestal walls and columns, arranged to suit the track layout. The tracks provide for train movements from each tube to any of the six tracks under the station, which in turn connect with the nine low-level tracks in the train yard. The masonry side-walls are of sandstone ashlar with Portland cement backing and foundations. The pedestal walls are of double-faced sandstone ashlar on Portland cement concrete foundations.

The elevation of the original ground varied from about +22 at the face of the station to +38 at the end of the twin tunnels between D and E Streets, N. E., and the top of the masonry walls varied from about +54 at the face of the station to +51 at the end of the tunnel. It will be noted, therefore, that nearly the entire bell-mouth proper was built above the original ground, and that the tracks were laid on a fill ranging from 0 at a point about 200 ft. north of the south end of the bell-mouth to about 10 ft. at the station line or north end.

On account of unstable foundation material, however, the masonry was carried in a number of cases to a depth of about 14 ft. below the original ground, the average depth being about 12 ft. The fact that it was not necessary to excavate below the original surface in the preparation of the roadbed greatly simplified the matter of drainage in the bell-mouth and, particularly, the depressed ventilating ducts, which were drained either into the reconstructed sewer under the plaza or into original sewers which were not disturbed.

All the steelwork, including girders, I-beams, buckle-plates, and columns, is encased in concrete. The minimum thickness of concrete over the top of the structure is 3 in., with a crown of 6 in. at the center. The entire top surface is water-proofed with four layers of Hydrex felt and compound, as applied in the tunnel, and protected with a 1-in. layer of cement mortar. The lower flanges of all beams are encased in Clinton wire cloth, as a reinforcement for the concrete protection.

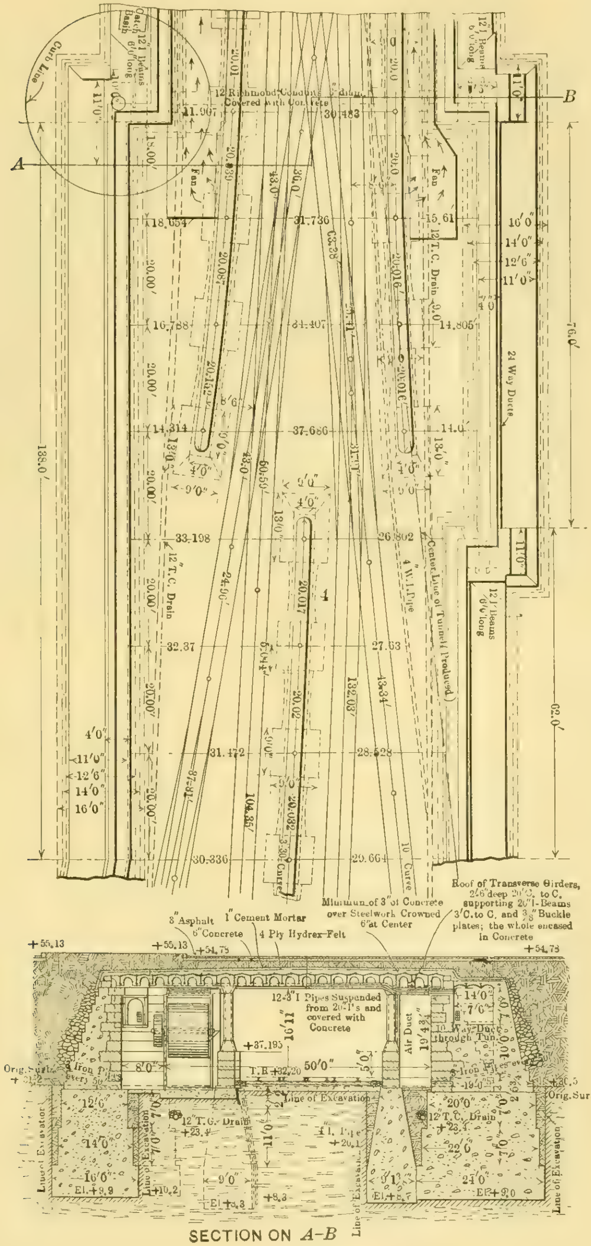
In the construction of the side-walls of the bell-mouth, provision was made for putting in a ventilating plant at a point about 200 ft. north of the end of the twin tunnels, the details of which are described under that heading.

The general excavation was started on July 16th, 1904, and completed on August 9th, 1904; the masonry was started on September 23d, 1904, and completed on January 31st, 1906; the erection of the superstructure was started on April 30th, 1905, and completed on August 30th, 1906.

The building of the masonry retaining and pedestal walls and the jacketing of the steelwork with concrete was done by McMullen and McDermott and the Hoffman Engineering and Contracting Company. The steelwork was furnished by the American Bridge Company, and erected by Brann and Stuart, of Philadelphia, Pa.

Ventilating Plant.

The development of the plans in connection with the reconstruction of the railroad terminals in Washington was based on the use of steam power in the handling of all regular trains and light equipment, to and from the terminal depot, in the passenger and freight yards, and through the First Street Tunnel. To avoid the smoke nuisance, so prevalent at all railroad terminals operated by steam power, provision was made for the use of coke on all yard engines, and the road engines had a supply of the same fuel for use within the District of Columbia.



SECTION ON *A–B*

FIG. 9.

Thus the smoke nuisance was abated, but the steam and gases emitted by the locomotives in the passenger and freight terminals, and the north and south approaches to the passenger depot, were left to be handled in another way. Had one large shed or a series of closed sheds been constructed over the station tracks, new difficulties would have been presented, but, on account of the use of the umbrella sheds, with ample space between, this difficulty was easily overcome, and, for the purpose of removing the steam and gases from the tunnel, the bell-mouth, and the track space under the station, a ventilating plant was placed in the bell-mouth about 200 ft. north of the north end of the twin tunnels. The plant consists of two electrically-operated fans, and the necessary ducts.

Before the adoption of this scheme, however, the kind of power to be used was considered, and it was the consensus of opinion of the owning and tenant companies that the time had not arrived when steam power could be, for any logical reason, economical or otherwise, supplanted by any other kind of power at this point, except, perhaps, on the score of cleanliness, and it was felt that this could be greatly improved by the use of smokeless fuel.

In support of this opinion it was pointed out that the use of electric power, for example, would require the establishment of separate locomotive terminals at or near the District limits, where intersected by the Washington and Metropolitan Branches of the Baltimore and Ohio Railroad and the Magruder Branch of the Philadelphia, Baltimore, and Washington Railroad, and at some point south of the Potomac River for the accommodation of all roads entering from the south; and, further, that the delay to all trains incident to the change from steam to electric locomotives, and *vice versa,* upon reaching or leaving the District, would cause a loss of time which would not be justified at present. It was felt, therefore, that, until all lines leading to Washington were electrified and operated so as to permit all trains to enter and leave the station without interruption at the District line, it was imperative that the use of steam power should be continued.

In determining the size and number of fans for the ventilation of the tunnel, the train intervals and the cubic contents of the tunnel and bell-mouth were taken into consideration. The reason for adopting the plan of forcing the impure air out of the south end of the tunnel, about 1 240 ft. distant, is obvious. The shortest train interval was

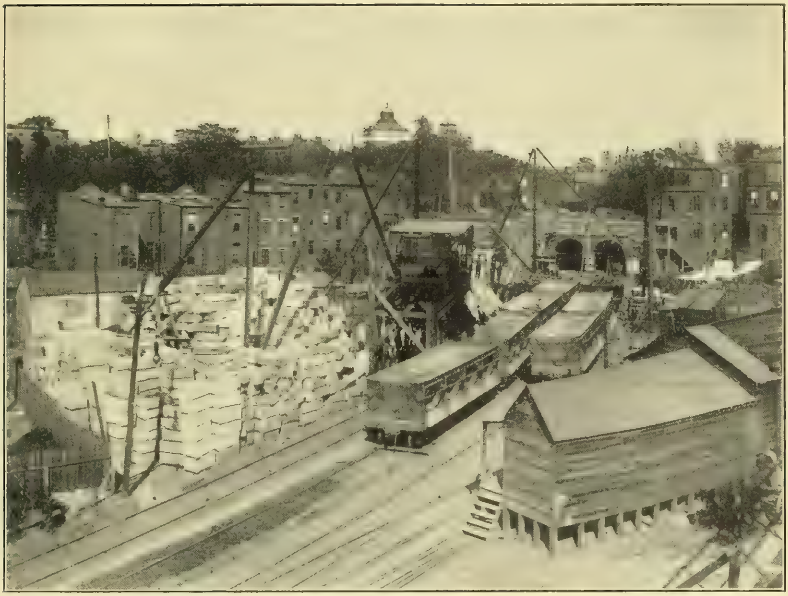


Fig. 1.—Washington Terminal Station: Storage Yard and Entrance to Tunnel, Looking Northeast.

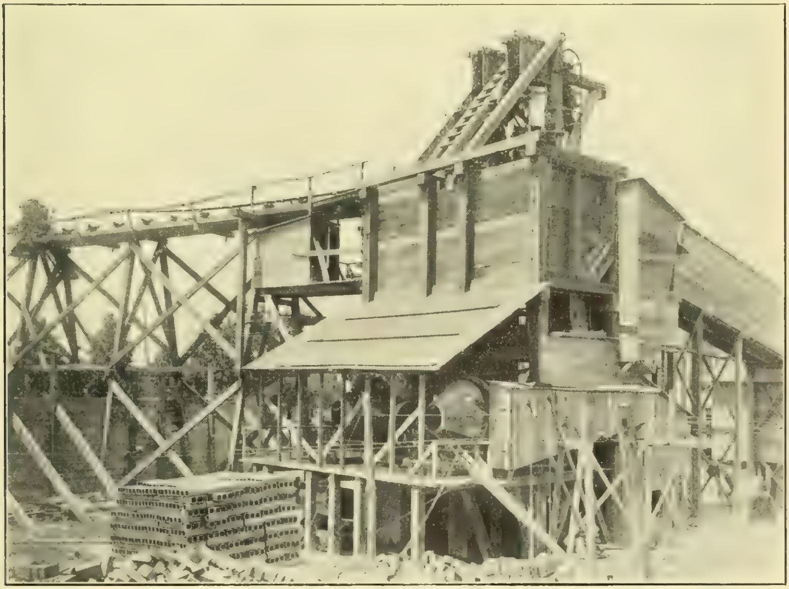


Fig. 2.—View of Mixing Plant, Showing Location of Mixers.

taken as 5 min., and to allow a safe margin it was proposed to clear the tunnel in 4 min. The combined sectional area of the two tubes was about 500 sq. ft. and the length 4 033 ft., thus the volume of air to be changed was 2 016 500 cu. ft. To this must be added the cubic contents of the portion of the bell-mouth between the end of the tunnels and the fans, amounting to about 150 000 cu. ft., giving an aggregate volume of 2 166 500 cu. ft.

Having decided on the train interval and obtained the cubic contents of the tunnel, it was found that, to meet the conditions, each fan would have to be capable of discharging about 270 000 cu. ft. of air per min. As the fans were to be placed about 665 ft. south of the north portal or end of the bell-mouth, and had to draw their air supply from that point, the contents of this space, amounting to about 1 250 000 cu. ft., had to be taken into consideration.

It will be noted that the cubic contents of the tunnel was about twice the cubic contents of the bell-mouth, and that to change the air in the bell-mouth would require normally about one-half the time required to clear the tunnel. As the tunnel could only be cleared by forcing other air into it and the bell-mouth, by passing the air through the tunnel, the impure air in the bell-mouth was used in part to perform this work; but, on account of the sectional area of the bell-mouth being about four times the combined area of the twin tunnels, the density of the steam and gases in the bell-mouth was only about one-eighth of that in the individual tubes for each train movement.

Had the density of the steam and gases been uniform throughout the entire length of the tunnel and bell-mouth, each fan would have been required to discharge an average of about 427 000 cu. ft. of air per min. to clear the entire space in 4 min., as specified. On the basis of clearing the tunnel in 4 min., 2 min. would have been required to clear the bell-mouth, and the total time required for changing the air in the tunnel and bell-mouth would have been 6 min. As previously stated, however, the air in the bell-mouth contained such a small percentage of steam and gases, compared with the tunnel proper, as to make it practically negligible in fixing the capacity of the plant.

The specifications for the plant, prepared by the Motive Power Department of the Pennsylvania Railroad Company, provided that the fans should be capable of delivering not less than 260 000 cu. ft. of air per min., against a pressure of 1½ in. of water, at a speed of from 135 to 145 rev. per min. at 120 b.h.p. The design of the nozzle and air ducts required to direct the air into the tubes was prepared by Charles S. Churchill, M. Am. Soc. C. E. The plant was made by the Cranford Paving Company, of Washington, D. C.

To meet the foregoing requirements, two fans, with wheels 10 ft. in diameter and 7 ft. in width, were furnished and put in by the Sirocco Engineering Company. They are operated by two 125-h.p., 2 300-volt, induction motors, made by the General Electric Company.

The discharge orifices of the fans are 8 ft. wide and 8 ft. 6 in. high, and have dampers which can be raised or lowered to vary the volume of the air discharged. These orifices are connected with the main ducts constructed along the side-walls of the bell-mouth, and extend from the fans to a cross-duct beneath the tracks at a point about 130 ft. south of the fans. The ducts are 18 ft. 8 in. in height and of varying width, the sectional area ranging from 114 to 190 sq. ft. The area of the nozzle is 118 sq. ft., or 59 sq. ft. for each tube.

The sides are formed by the side-walls of the bell-mouth and reinforced concrete curtain-walls built along the line of columns supporting the roof. The floors are of concrete 6 in. thick, and the roofs of ⅜-in. transite supported on T-irons, spaced at 24-in. centers resting on the reinforced curtain-walls and bridge seats. The cross-duct is 8 ft. wide and about 6 ft. 6 in. deep, and extends between the curtain-walls of the side-ducts. It is covered with ½-in. steel plates.

Between the cross-duct and the nozzle the air is split up and made to pass through a number of smaller ducts for the purpose of distributing it so as to have it enter the tunnels around their perimeter. The curtain-walls and supporting columns of the distributing ducts are of reinforced concrete, and all ducts beneath the tracks are covered with ⅜-in. steel plates. The construction above the springing line, conforming in section to the form of the tunnel arches, consists of ⅜-in. transite supported from the ceiling.

The equipment is belt-driven and, as originally built, the fans and motors had pulleys with diameters which drove the fans at 145 rev. per min. When put in operation, considerable trouble was caused by the slipping of the belts, due to the overload of the motor and the low speed of the belts. The original pulleys were then replaced by new ones having diameters of 114 and 27 in., respectively, which gave a higher belt speed and reduced the fan speed to 132 rev. per min.

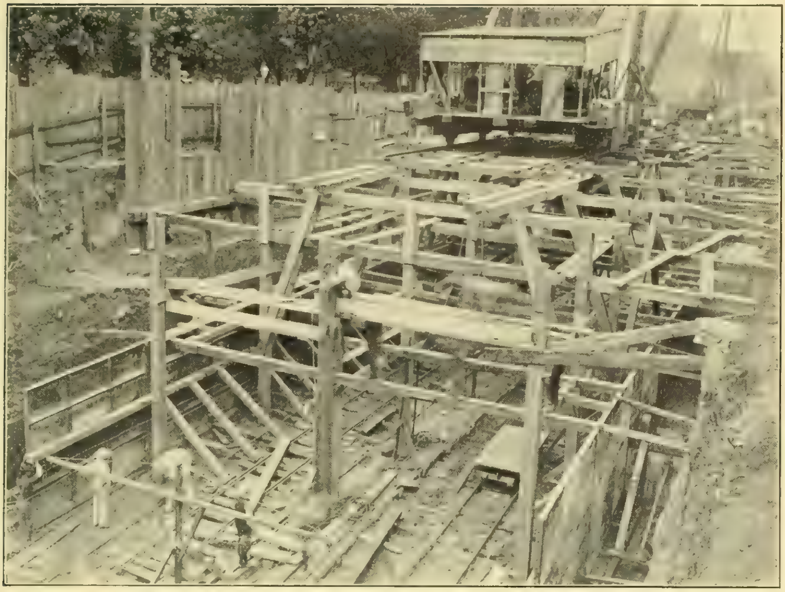


FIG. 1.—WASHINGTON TERMINAL STATION: SETTING STEEL PLATE FORMS USED IN SIDE-WALL CONSTRUCTION, CUT-AND-COVER TUNNEL.

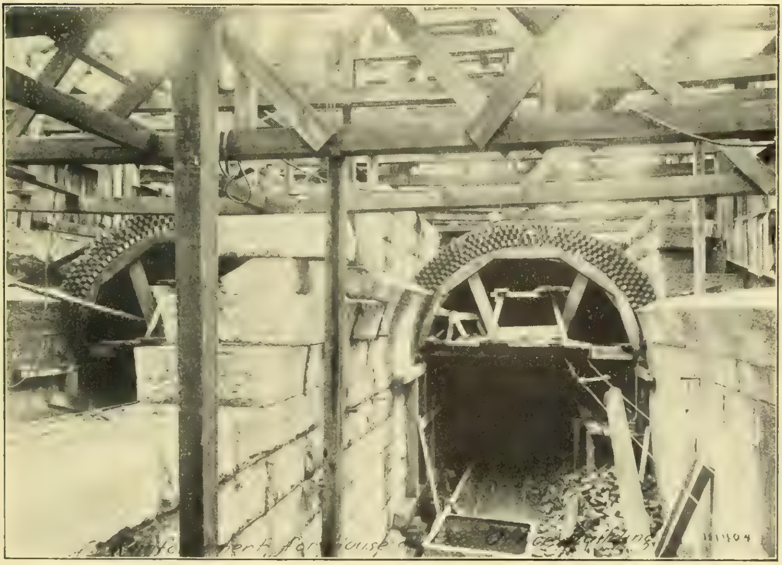


FIG. 2.—VIEW OF MASONRY CONSTRUCTION UNDER HOUSE OF REPRESENTATIVES' OFFICE BUILDING.

With the fans operating at the latter speed, tests were made for the purpose of determining the volume of air delivered, the pressure maintained in the ducts, the velocity of air through the tunnel, and the power required to drive the fans. In these tests it was found that the fans exceeded the capacity at which they were rated by the builders by more than 50%, and that, to avoid overloading the motors, it was necessary to reduce the area of discharge.

To reduce the delivery and the consequent consumption of power, the areas of the fan discharges were reduced from 68 to 46 sq. ft. This, however, did not prove an efficient method of reducing the power requirements, and the results of the tests were submitted to the Sirocco Engineering Company, with the request that a speed be recommended which would permit the operation of the fans with the discharge full open and not load the motors beyond their rated horse-power. The Sirocco Company estimated that if the fans were operated at 110 rev. per. min. they should be capable of discharging 320 000 cu. ft. per min. at 125 h.p.

Subsequent tests indicated that at a speed of 114 rev. per min. the fans would deliver 352 000 cu. ft. of air per min. with a power consumption of 89 kw., while the former tests showed a delivery of 400 000 cu. ft. with a power consumption of 175 kw. At 132 rev. per. min. the average velocity of air through the tunnels was about 18 miles per hour, at 114 rev. per. min. it was about 15.75 miles. The tests also showed a variation of approximately 50% in the velocity of the air at the different points of a section. The greatest velocity was noted in the upper portion of the section, the least near the tracks.

To determine whether the velocity of air was uniform at all points, readings were taken in both tubes at intervals of 400 ft., 1 100 ft., 1 600 ft., and 3 700 ft. from the north end of the twin tunnels. While there was more or less variation in the velocity at the different points of the section, the average velocity at all sections was found to be practically uniform. Similar observations were then made with the dampers in various positions, noting the power required, revolutions per minute of motors and fans, temperature of air and motors, and the humidity.

When the fan for the south-bound tube was operated, with the fan for the north-bound tube shut down, 13 kw. more power was required than when the other fan was running. This was due to the air being discharged through the combined nozzle and to the fact that a portion was discharged through the fan not in motion. The passage of trains in one tunnel affected the draft in the other, due to the air passing through the openings in the middle wall.

It was also noted that a train moving at its usual speed in the north-bound tunnel (against the draft) would stop the draft in the south-bound tunnel and reverse the draft in the north-bound tunnel, and that 4 min. were required to establish the draft at the south portal of the north-bound tunnel and 2 min. for the south-bound after the train had entered the south portal of the north-bound tube. Also that large quantities of steam and gas were forced through the openings in the middle wall into the south-bound tunnel and discharged through that tube. Both tunnels were practically clear within 6 min. after a train entered the north-bound tunnel, and within 3 min. after a train passed out of the south portal of the south-bound tunnel. This seemed to indicate clearly the advisability of placing the fans so as to produce the draft in the direction of the traffic, and the desirability of having a solid wall between the two tubes.

Track Work.

The tracks on the terminal property between the north side of Florida Avenue and the north end of the twin tunnels under First Street were laid with No. 1, Am. Soc. C. E. standard, 85-lb., steel rails. The tracks in the First Street tunnel were laid with No. 1, Pennsylvania Railroad standard, 100-lb., steel rails. With the exception of a small percentage of No. 2, all tracks were laid with No. 1 white oak ties and ballasted with stone. When tracks were laid on fills they were originally ballasted with cinder and later raised on stone.

The tracks on the joint coach and engine yard were laid with Am. Soc. C. E. standard, 85-lb., steel rails, No. 1 being used in all leads, turnouts, and thoroughfare tracks, with No. 2 in the interior tracks. About 90% of the ties used on this section were No. 1 white oak and Georgia yellow pine, the remainder were No. 2 white oak and Georgia yellow pine. All tracks were ballasted with cinder.

The main tracks of the Washington and Metropolitan Branches of the Baltimore and Ohio Railroad, from Florida Avenue northward and eastward, were laid with No. 1, Am. Soc. C. E. standard, 85-lb., steel rails on No. 1 white oak ties, and ballasted with stone. The tracks of the Magruder Branch of the Philadelphia, Baltimore, and Washington Railroad north of New York Avenue were laid with No. 1, Pennsylvania Railroad standard, 100-lb., steel rails on No. 1 white oak ties, and ballasted with stone. Between Florida and New York Avenues, 85-lb. rails were used in order to avoid changes in frogs and interlocking in connection with the scissors crossing.

The frogs and crossings in all tracks on the terminal property, in the scissors crossing at the throat of the coach and engine yard, and at the east and west ends of the **Y** connecting the Washington and Metropolitan Branches of the Baltimore and Ohio Railroad, except the stub sidings near the power-house and express building, are of manard or manganese steel. All frogs in the coach and engine yard and in the stub tracks above noted, and all switches on the entire improvement are of Bessemer steel.

The object of placing two kinds of special frog construction in the track layout was to test the merits of manard and manganese steel. In order to obtain an unbiased opinion, frogs of each make were placed on either side of a diamond crossing near L Street, where the traffic would be the same on each group. The results, thus far, after two years of service, are very gratifying, but show no advantages of one over the other.

All switch points in the regular turnouts are 16½ ft. long; those in the slip-switches are 15 ft. long. With the exception of a few of No. 7 in the stub tracks, all frogs on the entire passenger terminal are No. 8. The slip-switches in the east and west ends of the **Y** connection are No. 10, all other slip-switches are No. 8. The ends of all stub tracks have Ellis patent bumping posts.

Construction Organization.

Acting under the power and authority vested in the Baltimore and Ohio Railroad Company by the Act of Congress approved February 12th, 1901, relating to the elimination of grade crossings in the District of Columbia, a terminal company was incorporated on December 6th of the same year, for the purpose of carrying out the provisions of the above Act. The entire capital stock issued under the above Act of Congress was owned and held by the Baltimore and Ohio Railroad Company, and the seven directors chosen for the purpose of incorporation were selected from among the officers and employees of that company.

Later, when the bill providing for a union station was prepared, it contained a provision permitting the construction of the station and approaches by the Terminal Company, on condition that one-half the capital stock already issued should be acquired by purchase by the Philadelphia, Baltimore, and Washington Railroad Company, and that it should be entitled to subscribe for and acquire equally with the Baltimore and Ohio Railroad Company any stock afterward issued by the terminal company.

When this bill became a law the personnel of the board of directors of the Terminal Company was changed so as to give both companies representation, as their interests might appear. The officers were then selected from among the officers of the two railroad companies, the by-laws providing that under certain conditions the office of President should alternate annually between the Presidents of the Baltimore and Ohio and the Pennsylvania Railroad Companies.

The ownership of the Washington Terminal Company embraces all tracks and property from the north side of Florida Avenue on the north approach, to the south end of the First Street Tunnel on the south approach. It includes, therefore, the sections known as terminal approach, train-shed, depot, and First Street Tunnel, together with all buildings and structures included within those limits. The coach and engine yard is owned jointly and equally by the Washington Branch of the Baltimore and Ohio Railroad Company and the Philadelphia, Baltimore, and Washington Railroad Company, but is operated and maintained by the Terminal Company. The operating and carrying charges of the Terminal Company, covering, as stated before, the depot and approaches, and the joint equipment yard, are prorated against the railroad companies using the facilities on the basis of cars and engines handled for each company.

The main tracks north of Florida Avenue are owned and maintained by the respective roads entering the terminal from the north. The main tracks between the south end of the First Street Tunnel and the connection with the main tracks on Virginia Avenue, over which the trains of all roads entering from the south are handled, are owned by the Philadelphia, Baltimore, and Washington Railroad Company, but operated and maintained by the Terminal Company.

The engineering work of the entire project was placed in the hands of the Chief Engineers of the owning companies, with authority to make such sub-division as they saw fit. At that time Mr. William

H. Brown was Chief Engineer of the Pennsylvania Railroad Company, and the late Joseph M. Graham, M. Am. Soc. C. E., was Chief Engineer of the Baltimore and Ohio Railroad Company. Associated with the above gentlemen in the preparation of the general plans for the terminal were Joseph T. Richards, M. Am. Soc. C. E., of the Pennsylvania Railroad Company, and Mr. L. G. Haas, of the Baltimore and Ohio Railroad Company, and later the General Superintendents of Motive Power Departments of the above roads.

At a meeting of the Chief Engineers it was agreed that the construction work contiguous to the tracks of the respective companies should be placed under the jurisdiction of the Engineering Departments of these companies. It was also agreed that the design and installation of the machinery in the main power-plant should be handled by the Motive Power Department of the Pennsylvania Railroad Company, while the design and arrangement of the joint roundhouses and shops, and the installation of their machinery should be handled by the Motive Power Department of the Baltimore and Ohio Railroad Company.

As much of the space north of Massachusetts Avenue was either occupied by or contiguous to the Baltimore and Ohio Railroad Company's tracks and yards, and as the construction of the south approach could be handled to the best advantage from a connection with the Philadelphia, Baltimore, and Washington Railroad Company's tracks on Virginia Avenue, the north line of Massachusetts Avenue was decided upon as the logical dividing line between the work to be handled by the respective companies.

This placed all work north of Massachusetts Avenue, except the north end of the bell-mouth and the design and installation of machinery in the main power-plant, under the jurisdiction of the Engineering Department of the Baltimore and Ohio Railroad Company, with the writer in direct charge, and all work south of Massachusetts Avenue, together with the north end of the bell-mouth, under the jurisdiction of the Engineering Department of the Pennsylvania Railroad Company, with J. T. Stuart, M. Am. Soc. C. E., in direct charge.

The work under the former company embraced a portion of the plaza, the station, train-sheds, approach, express terminal, main power-house, and the K Street and Massachusetts Avenue interlocking towers, on the terminal property, and the coach and engine yard, power-houses, engine-houses and shops, on the joint property, together with the main tracks of the Washington and Metropolitan Branches of the Baltimore and Ohio Railroad Company, and the Magruder Branch of the Philadelphia, Baltimore, and Washington Railroad Company contiguous thereto. The work under the latter company embraced the bell-mouth under Massachusetts Avenue plaza, the First Street Tunnel, the connection between the south portal of the tunnel and the tracks of the Philadelphia, Baltimore, and Washington Railroad Company on Virginia Avenue, and the Magruder Branch east of the old Washington Branch.

The architectural work on all buildings and structures within the terminal area, embracing the station, umbrella sheds and platforms, power-house, express building, and K Street and Massachusetts Avenue interlocking towers, was executed by D. H. Burnham and Company, of Chicago, Ill. This company prepared contract drawings and specifications covering the various classes of work involved, and invited bids. The propositions were addressed to the Chief Engineers of the Pennsylvania and Baltimore and Ohio Railroad Companies, by whom they were opened. The contracts were made by the Terminal Company and executed by its President. The detailed drawings were then prepared, and the construction was supervised by the architects under the general direction of the writer as the Terminal Company's representative. Under the above organization, work on the general terminal improvements was started in August, 1903. On February 1st, 1904, Mr. Graham resigned as Chief Engineer of the Baltimore and Ohio Railroad Company and was succeeded by the late Daniel D. Carothers, M. Am. Soc. C. E., under whose general direction the work entrusted to the Engineering Department of the Baltimore and Ohio Railroad Company was carried to completion.

On February 1st, 1904, Mr. Stuart resigned and was succeeded by Robert Farnham, Jr., Assoc. M. Am. Soc. C. E., under whose direct supervision the work was completed. On March 28th, 1906, Mr. Brown, having reached the age limit under the rules of his company, was retired and Mr. Alexander C. Shand was appointed his successor. Under his general direction the work placed in charge of the Engineering Department of the Pennsylvania Railroad Company was completed.

OPERATION ORGANIZATION.

The operation organization of the Terminal Company consists of a board of managers, a superintendent, an auditor, an engineer, a master mechanic, a ticket agent, a baggage agent, a station master, and a general yard master. The board of managers is composed of representatives of the owning and tenant companies as follows: Pennsylvania, Baltimore and Ohio, Washington Southern, Southern, and the Chesapeake and Ohio, five members in all, reporting to the board of directors of the Terminal Company.

The superintendent is the active head of the organization, and reports to the board of managers. The heads of the various departments report to the superintendent. In addition to performing the duties of that office, the auditor is also superintendent of the terminal relief department. The engineer has charge of all matters pertaining to the maintenance of track, interlocking plants, and structures. The master mechanic has charge of the repairs and general maintenance of equipment, and jurisdiction over the power-stations.

The ticket agent has charge of the sale of tickets for all roads entering the terminal. The baggage agent exercises jurisdiction over the baggage- and parcel-rooms. The station master has charge of the handling of trains in and out of the station, and the general yard master exercises similar jurisdiction over the handling of trains and equipment in the yards. Each of the above departments is provided with the requisite force of men to perform the duties devolving upon it, to keep the terminal a model of neatness and order.

The duties of treasurer are performed by the treasurer of the Baltimore and Ohio Railroad Company, while those of purchasing agent are performed by the purchasing agent of the Pennsylvania Railroad Company.

Conclusion.

Although incomplete, the terminal was thrown open to the public on Sunday morning, October 27th, 1907, when the Baltimore and Ohio Railroad Company abandoned its station at New Jersey Avenue and C Street and occupied temporary quarters in the east end of the new station. Three weeks later, November 17th, the Philadelphia, Baltimore, and Washington Railroad Company abandoned its Sixth Street station and transferred its traffic to the new station.

As the Baltimore and Ohio Railroad Company was the first to reach Washington with its railroad and the first to be organized as a transportation company, not only in America, but in the world, it seems but a fitting culmination of this great work, with which it had so much to do, that it should be the first to occupy the new station.

October 27th, 1907, will go down in history as marking the date upon which the railroads of the District of Columbia took the final step in compliance with the Act of Congress relating to the elimination of grade crossings in the City of Washington and the District of Columbia.

The old C Street Station, which for so many years served the patrons of the first railroad to reach the National Capitol, has been removed, and the site has been filled to the level of the surrounding streets, in line with the general change in the topography of this section of the city. The Sixth Street Station has also been removed, and all evidence of this once busy center has been obliterated. Its removal will permit the development of the Mall along the lines laid down by the Park Commission.

The Baltimore and Ohio Railroad Company monopolized steam railroad transportation to and from Washington until in the late Sixties, when the Baltimore and Potomac Railroad Company, now the Philadelphia, Baltimore, and Washington Railroad Company, established a station south of the Mall, but in 1872 changed its location to Sixth and B Streets, N. W., near Pennsylvania Avenue. The stations of both roads figured conspicuously in many historic events, and many noted personages passed their portals. Their passing brings up many memories, but these will soon fade, leaving but imperfectly written records to enlighten future generations.

In conclusion, the writer wishes to express his high appreciation of the assistance rendered by the officers and employees of the Pennsylvania and Baltimore and Ohio Railroad Companies in the execution of the above work, especially the late Joseph M. Graham and Daniel D. Carothers, former Chief Engineers of the Baltimore and Ohio Railroad Company, and Messrs. William H. Brown and Alexander C. Shand, former and present Chief Engineers of the Pennsylvania Railroad Company, under whose joint general direction the above work was executed, and to Mr. Robert Farnham, Jr., who furnished plans and photographs and otherwise assisted in the preparation of the description of the work on the First Street Tunnel.

Vol. XXXVI. AUGUST, 1910. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE NEW YORK TUNNEL EXTENSION OF THE PENNSYLVANIA RAILROAD.

THE LONG ISLAND APPROACHES TO THE EAST RIVER TUNNELS.

By George C. Clarke, M. Am. Soc. C. E.

To be Presented September 21st, 1910.

The portion of the Pennsylvania Railroad Tunnel Extension into New York City described in this paper extends from East Avenue to Thomson Avenue, in Long Island City, Borough of Queens, and covers that portion of the work on which the line changes from an underground to a surface railroad, and the entrance to the Sunnyside Yard.

The work consisted of 6 950 lin. ft. of cut-and-cover tunnel; 2 555 lin. ft. of retaining wall and invert approach to tunnels; one overhead highway bridge at Hunter's Point Avenue; one single-track steel viaduct and one double-track viaduct, both with concrete floors and the latter having a concrete approach; grading for surface tracks and streets; a drainage system, requiring 367 000 cu. yd. of excavation, of which 61 000 cu. yd. were rock; the placing of 145 000 cu. yd. of concrete, containing 1 520 tons of reinforcing bars and covered by 664 000 sq. ft. of felt and pitch water-proofing, six-ply in thickness; 215 000 lin. ft. of piles in foundations; 217 000 lin. ft. of electric ducts;

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

18 000 lin. ft. of cast-iron and vitrified drain pipe of various sizes, and 2 400 tons of structural steel.

ALIGNMENT AND GRADES.

At East Avenue the four tunnels lie in the same order as that in which they leave the Terminal Station in Manhattan, Tunnel *A* being the northernmost and Tunnel *D* the southernmost tube, and, although the two pairs are much closer together than through Manhattan, the distances from center to center of the tubes being, *A* to *B* 30 ft., *B* to *C* 28 ft., *C* to *D* 32 ft., and the bearing of the southerly pair slightly more to the north than that of the northerly pair, they still comprise in effect two double-track railroads, *A* and *C* being west-bound, and *B* and *D* east-bound tracks. They are at that point all on 1° 30′ curves. The alignment and grades are shown on Plate CXXVIII.

In elevation of tracks, *A, B,* and *D* are the same, the top of rail being 46 ft. below the surface, and the grades 1.5, 1.25, and 1.22%, respectively, while *C* is but 27 ft. below the surface, and on a 1.9% grade.

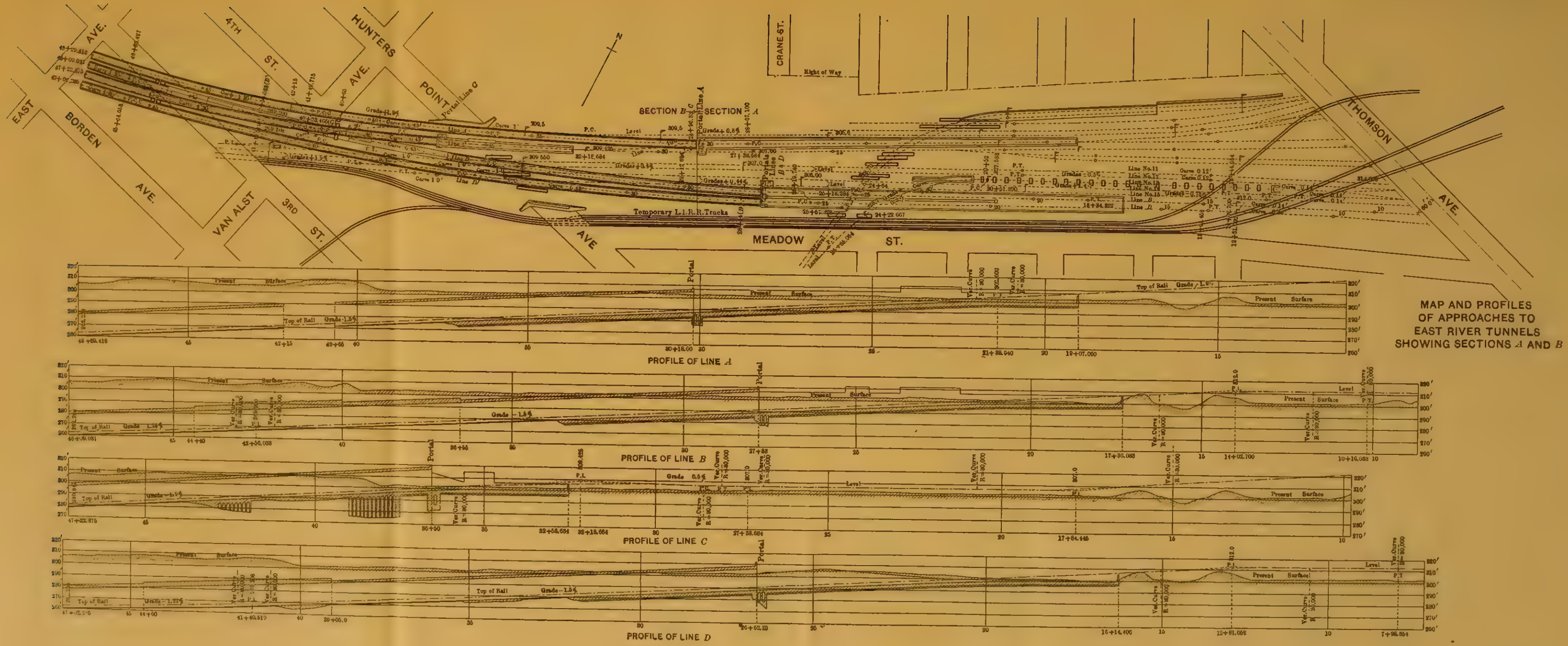
East from East Avenue, Tunnels *A* and *C* continue on the 1° 30′ curve for a distance of about 700 ft., then they compound into 43′ curves which continue to beyond the portals and bring the lines into parallel tangents side by side, whereas Tunnels *B* and *D* compound from the 1° 30′ curves to 43′ curves within 180 ft. of East Avenue, thus throwing them to the south and causing *B* to pass under *C* and approach *D* until they emerge through a joint portal at a distance of 2 060 ft. from East Avenue into slightly converging tangents, at which point Line *B* is 115 ft. distant from Line *C* and the four lines form a right-hand four-track railroad, in which order they continue into the Sunnyside Yard.

The portal of Line *A* is slightly west of the joint portal for Lines *B* and *D*, being 1 815 ft. from East Avenue, whereas the heavier grade on Line *C* brings its portal just west of Hunter's Point Avenue, and 1 100 ft. from East Avenue.

DESIGN.

The clearance line in the tunnels above top of rail is identical for all sections, and very similar to the single-track tunnels under Man-

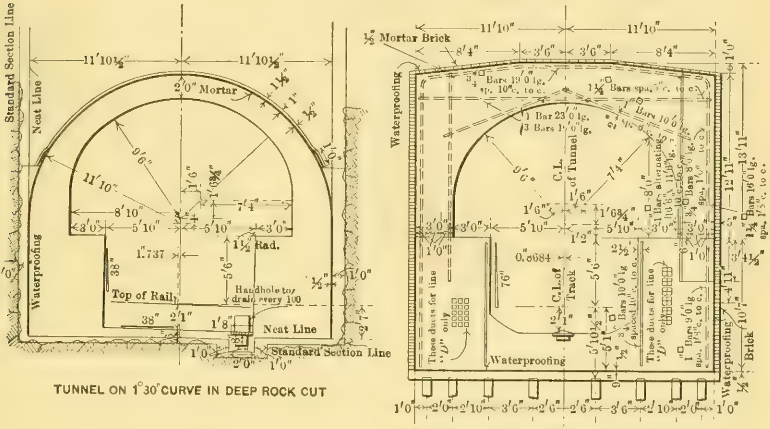
PLATE CXXVIII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.



MAP AND PROFILES
OF APPROACHES TO
EAST RIVER TUNNELS
SHOWING SECTIONS *A* AND *B*

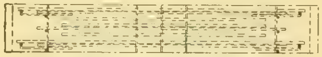
hattan, but the varying conditions of foundation and adjoining structures required variations in both floor and arch roof. Fig. 1 shows two typical sections. Where the structure is on a rock foundation, as shown in Section No. 1, the floor has a minimum thickness of 6 in. and is not water-proofed, but, where it is supported on piles, the floor necessary to distribute the load over the piles properly is heavy enough to resist the upward pressure of the water, and therefore the water-proofing is carried under the tunnel, being placed on a sub-base of

TYPICAL SECTIONS OF TUNNELS.



TUNNEL ON 1°30' CURVE IN DEEP ROCK CUT

SECTION TO BE USED WHERE PILES ARE REQUIRED



PLAN SHOWING SPACING OF BARS

Note:- All bars to be corrugated or twisted square steel bars.

FIG. 1.

9 in. of concrete, 3 in. about the head of the piles and 6 in. over them. All the tunnels are water-proofed above the floor level, and in those supported on piles the water-proofing forms a complete envelope.

Only in those sections where the original rock stood at an elevation of 5 ft. or more above the bench-wall, as in Section No. 1, Fig. 1, is any arch action required in the roof to make it stable; under all other conditions sufficient steel was put in the sides and top of the arch to make them stable as beams. The amount of reinforcement varied with the depth of cover and the position of the adjacent surface tracks; Section No. 2, Fig. 1, shows a typical section of tunnel on pile foundations. Tunnels built on rock, the original surface of which was less than 5 ft. above the bench-walls, are similar to that section above the top of rail and similar to Section No. 1 below that point.

The crossing of Tunnel *C* over Tunnel *B* required special sections. Where the tunnels approached each other from the west, Tunnel *B* was entirely in rock excavation, the original surface of which was either above or slightly below the floor of Tunnel *C*; little variation, therefore, was required, as shown by Fig. 2.

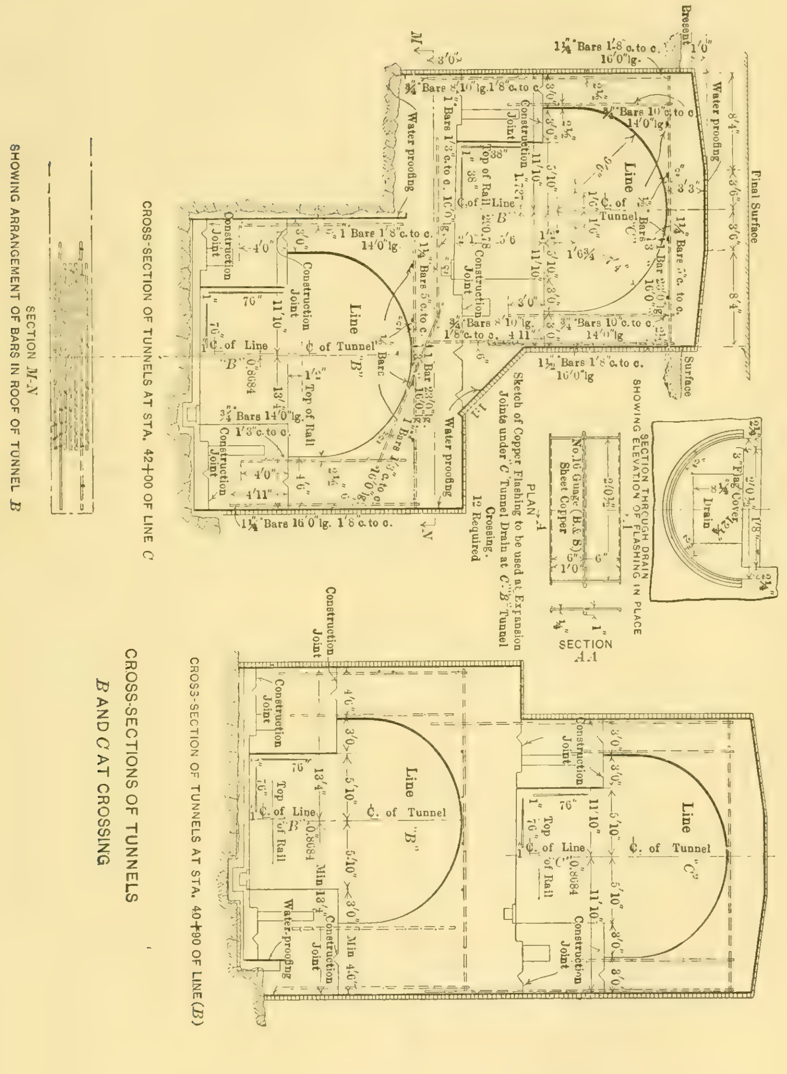
It will be noted that the only variation in these sections of either tunnel from the usual form consists of a thickening of the bench- and side-walls of Tunnel *B* and the batter given the bench-wall of Tunnel *C* in order to distribute the load over Tunnel *B*. Where Tunnel *C* left Line *B* toward the east the rock was much lower in comparison with Tunnel *C* and, to save concrete, the expedient was resorted to of supporting that portion of Tunnel *C* not resting on *B* on a cellular construction, formed by a series of jack-arches in conjunction with the north walls of Tunnels *B* and *C*, as shown by Fig. 3. After Tunnel *C* had entirely cleared Tunnel *B* the jack-arches were continued to the portal, the side-walls being omitted below the floor of *C*, thus forming a concrete viaduct by which Line *C* was supported.

It was not expected that the drain in Tunnel *C* at its crossing over Tunnel *B* would carry any water except when the sump at the portal might be allowed to overflow, and, to prevent leakage at such times through the joints between sections into Tunnel *B*, a copper flashing, shown on Fig. 2, was designed, with a bellows fold lying in the joint between sections to permit expansion.

The splicing chambers, refuge niches, ladders, etc., in all tunnels were similar in design and spacing to those in the cross-town tunnels under Manhattan.

At the several portals, there are sumps for catching the drainage from the inverts, together with chambers for the pumps necessary to care for that water; there are also concrete stairs from the surface to the bench-walls and tunnel floor. Plate CXXIX shows three longitudinal sections and one cross-section of the *B-D* portal; the other portals are similar, but each is for a single tunnel.

The retaining wall and invert approaches to the tunnels are in form and effect practically dry docks, the material against which they protect the tracks being mud instead of water. Plate CXXX shows


CROSS-SECTION OF TUNNELS AT STA. 42+00 OF LINE C
Line "C"
¢. of Tunnel
Line "B"
¢ of Tunnel "B"
¢. of Line "B"
¢ of Line B
Top of Rail
Construction Joint
Water proofing
Final Surface
Surface
Present
1¼" Bars 1'8" c. to c. 16'0" lg.
¾" Bars 8'10" lg. 1'8" c. to c.
¾" Bars 10" c. to c. 14'0" lg.
1" Bars 1'3" c. to c. 16'0" lg.
1¼" Bars 5" c. to c.
1½" Bars 1'8" c. to c. 16'0" lg.
1 Bars 1'8" c. to c. 14'0" lg.
¾" Bars 14'0" lg. 1'3" c. to c.
1¼" Bars 16'0" lg. 1'8" c. to c.
M
N
SECTION M-N
SHOWING ARRANGEMENT OF BARS IN ROOF OF TUNNEL B
SECTION THROUGH DRAIN
SHOWING ELEVATION OF FLASHING IN PLACE
3" Flag Cover
Drain
PLAN
No. 16 Guage (B. & S.) Sheet Copper
SECTION A-A
Sketch of Copper Flashing to be used at Expansion Joints under C Tunnel Drain at C-B Tunnel Crossing.
12 Required
CROSS-SECTION OF TUNNELS AT STA. 40+90 OF LINE (B)
Min 13'4"
Min 4'6"
Water-proofing
11'10"
5'10"
13'4"
3'0"
4'6"
0.8684
7'6"

CROSS-SECTIONS OF TUNNELS
B AND *C* AT CROSSING

FIG. 2.

a plan and sections of the common invert for Lines *B* and *D*. Those for Lines *A* and *C* are for one track each, but are similar to that for *B-D* with the portion between the center lines of *B* and *D* omitted and the 15-in. vitrified drain reduced to a 12-in. and placed in the side-wall opposite the ducts.

The inverts, with the exception of 150 ft. of Line *A* in the vicinity of Pierson Street, are all supported on pile foundations, and the necessity of keeping the heads of the piles below the ground-water level required that the outer end of the invert be built on a flatter grade than the tracks, the intervening space between floor and base of tie, about 6 ft. at the curtain-wall, being filled with broken stone.

The purpose of the center-wall, built westward from Station 22 + 21 between Lines *B* and *D*, is to prevent the upward pressure of the mud from lifting and breaking the concrete floor, and, incidentally (as does each side-wall), it furnishes column foundations for the elevated freight lines crossing the yard.

Contractors.

As stated in the paper by Alfred Noble,* Past-President, Am. Soc. C. E., the work was done by Naughton Company and Arthur McMullen, with the exception of the steel and concrete superstructure of the viaducts, and a length of about 140 ft. of Tunnel *A*, at the intersection of Fourth Street and Van Alst Avenue, which was built by the Degnon Contracting Company in conjunction with its construction of the Steinway Tunnel which at this point rests partly on top of Tunnel *A*. The Secretary and Manager for the contractors was George W. McNulty, M. Am. Soc. C. E., and through the greater part of the work their Resident Engineer was C. W. S. Wilson, M. Am. Soc. C. E.

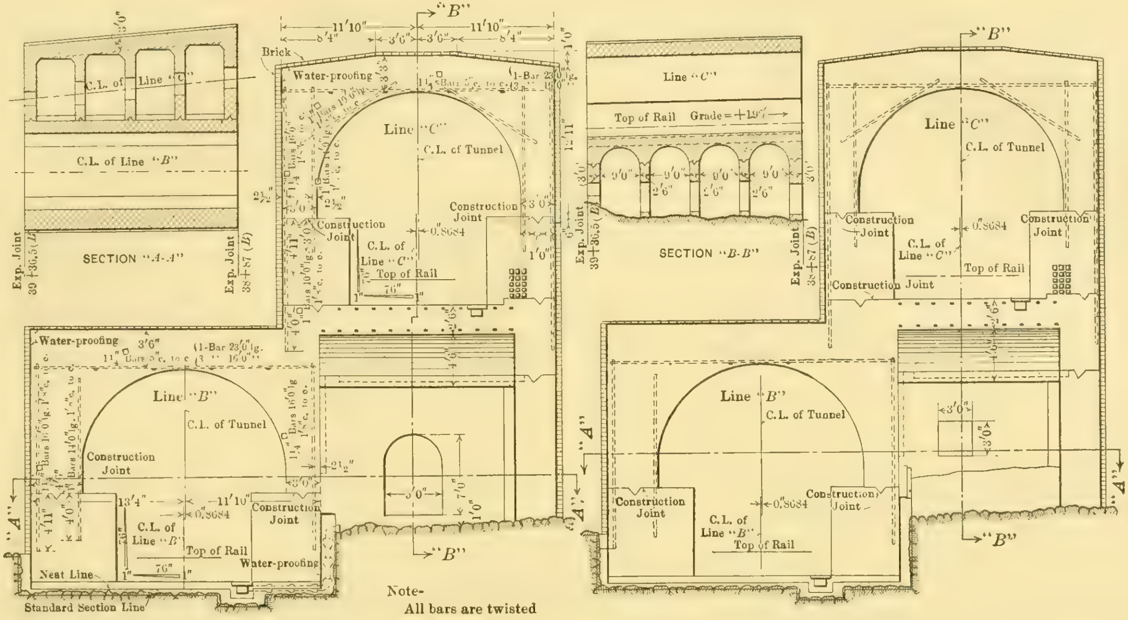
They began work on June 4th, 1907, and completed their contract on December 31st, 1909, with the exception of a small amount of cleaning up, which could not be finished until the Long Island Railroad tracks were moved from a temporary position which they occupied during most of the time that the work was in progress.

Condition of Ground at Beginning of Work.

The condition at the beginning of the work is shown on Plate CXXXI. The tracks of the Long Island Railroad occupied the surface

---

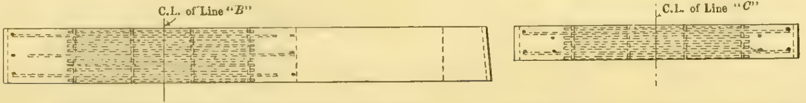
* *Transactions*, Am. Soc. C. E., Vol. LXVIII, p. 62.



Note-
All bars are twisted
square steel bars

CROSS-SECTION OF TUNNELS AT STA. 38 + 94.5(*B*)

CROSS-SECTION OF TUNNELS AT STA. 39 + 29(*B*)



PLAN SHOWING SPACING OF BARS IN ROOF OF TUNNEL "*B*"

PLAN SHOWING SPACING OF BARS IN ROOF OF TUNNEL *C*

TYPICAL CROSS-SECTIONS OF
TUNNELS ON
LINES *B* & *C* AT CROSSING

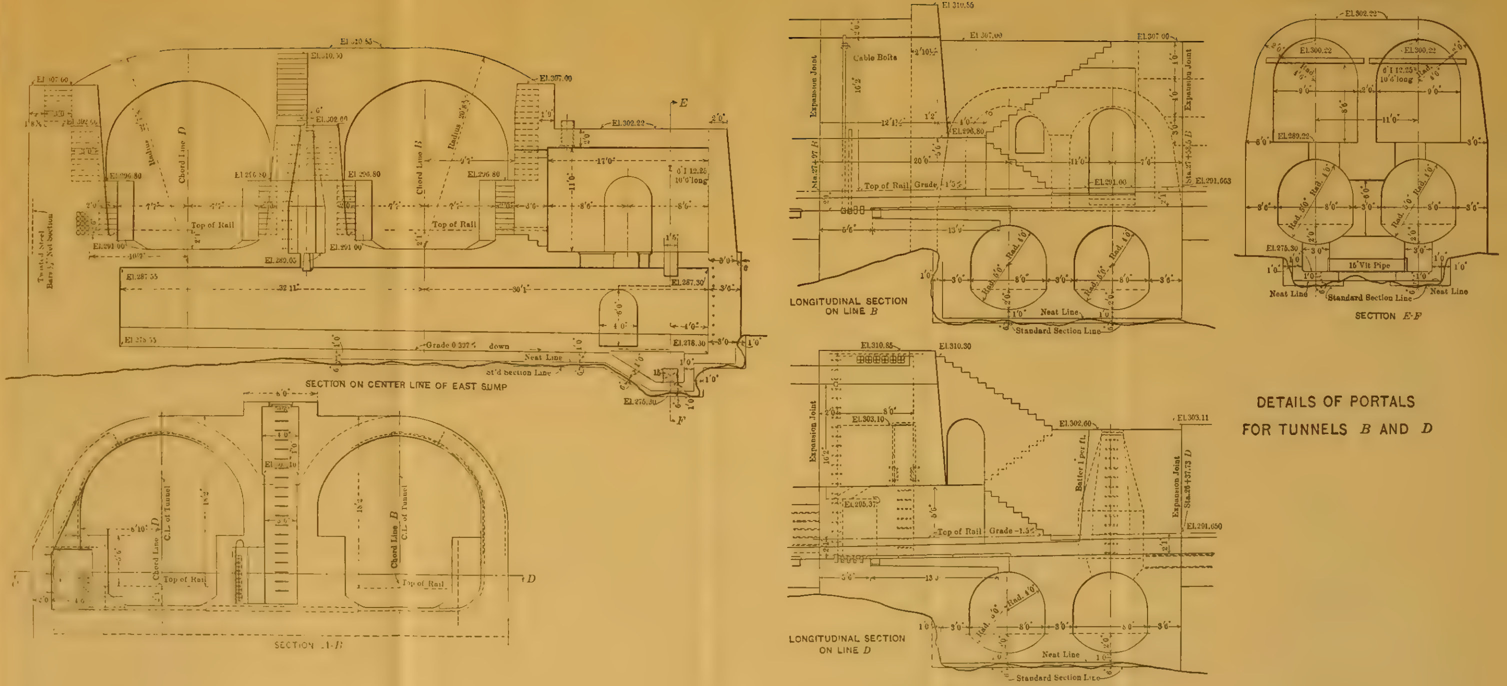
FIG. 3.

on the line of portions of the work from Third Street near Van Alst Avenue to Thomson Avenue, the elevation of the top of rail varying from 303 to 304 ft., or from 3 to 4 ft. above mean high tide. Hunter's Point Avenue crossed these tracks on a through truss bridge at an elevation of 322 ft., the length of the bridge being 85 ft. and the approaches to it on embankments, which on the northerly side of the bridge were practically level, but on the southerly side descended from the bridge on a 2% grade. Meadow Street had been graded to an average elevation of 307 ft. from Hunter's Point Avenue to Nott Avenue, and fills of varying widths existed on line of the cross-streets from Nott Avenue to Arch Street, extending from Meadow Street to within 20 or 30 ft. of the railroad tracks. The remainder of the area east of Van Alst Avenue was a swamp over which the water stood at an elevation of 302 ft., the depth varying from 0 to 4 ft. West of Van Alst Avenue the ground had all been filled and the swamp mud compressed to a thin water-tight stratum. The surface of the swamp was a bed of tough peat, and underlying it there was from 3 to 15 ft. of black swamp mud which when stirred up with water became perfectly liquid, but, in its original condition, was practically impervious. The fills made for the railroad and streets had displaced or compressed to a very thin layer the swamp mud in those particular locations.

Underlying Rock.

The elevation of the underlying rock varied greatly, rising to the sub-grade of the railroad tracks at Anable Avenue, from which point it sloped in all directions until it was about 40 ft. below the surface at Nott Avenue and from 40 to 60 ft. below between Davis and Arch Streets. West of Hunter's Point Avenue the rock rose rapidly again until at East Avenue the entire section of each tunnel, except *C*, was below its surface. Where the rock east of Hunter's Point Avenue lay within a few feet of the surface, the mud extended entirely to it, but, as the rock fell off, different strata of sand and clay were encountered. Toward the east, and south of the high point of rock at Anable Avenue, the sand predominated, and west and southwest of that point was found more clay which, toward Hunter's Point Avenue, contained many boulders, varying in size from a few cubic feet to 8 or 10 cu. yd. This stratum of clay was practically water-tight and quite firm when surface water was kept from it, but became "soupy" very quickly when

PLATE CXXIX.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.



SECTION ON CENTER LINE OF EAST SUMP

SECTION A-B

LONGITUDINAL SECTION ON LINE B

LONGITUDINAL SECTION ON LINE D

SECTION E-F

DETAILS OF PORTALS FOR TUNNELS B AND D

wet. Immediately overlying the rock, in practically all cases where it was uncovered 12 ft. or more below the surface, there was a water-bearing stratum of coarse sand and gravel, and there was ample evidence (of which one or two instances will be noted) that the same water-bearing stratum existed where the rock was not uncovered. On the line of *B-D* invert, near Station 19 (*D*), the borings were too far apart to give sufficient information as to depth of rock, and a 2-in. pipe was driven down at several points. At one of these points, it being found difficult to remove the pipe, it was allowed to remain, and water flowed from its top, the flow continuing even after the excavation for the invert was completed and until the pipe was finally removed. Many piles which were slightly heart-checked showed a small flow of water through the checks when the surrounding ground was 1 ft. or more below their tops, and, during cold weather, mounds of ice were frequently formed on tops of piles which would have been dry except for the water rising through them.

The strike of the rock was almost directly east and west, about at right angles to the general strike underlying the portion of the work in Manhattan. The pitch was generally about 90°, although varying greatly from that angle for short stretches.

The rock uncovered was a very good quality of gneiss, sometimes degenerating to mica schist, but for the greater part containing but little mica and in very minute particles, so that much of that excavated made an excellent concrete stone, about 1 cu. yd. of crushed stone being obtained for each yard of rock excavated.

Construction.

The first step taken by the contractors was to drain the area east of Hunter's Point Avenue. Two 4-in. centrifugal pumps, operated by a 40-h.p. boiler, were placed along the railroad near Court Street, and a main ditch was opened, parallel to the tracks, with cross-ditches leading from the ponds between the filled streets. The pumping plant began working on July 10th, 1907, discharging into Dutch Kills Creek over low ground lying south of Meadow Street, and in less than 24 hours had lowered the water to such an extent that only one pump at a time could be run. After one week's pumping very little water remained. Throughout the work no difficulty was caused by the surface-water, which looked quite formidable at the start, but pumping had to be continued for a few hours per day with the surface plant until the work was practically completed.

A comparison of Plates CXXVIII and CXXXI will show that the Long Island Railroad tracks cut the work into two sections, and that in their position, shown on Plate CXXXI, they effectually prevented any work on a large part of the construction for and in the vicinity of Hunter's Point Avenue. As it was very desirable that the bridge on that avenue should be completed and the traffic restored to it as early as possible, a roadbed had been graded for the tracks on the line of Meadow Street, as shown on Plate CXXVIII, previous to letting the contract. The moving of the tracks to that location required the cross-connection for freight near the outer end of the work, and made very desirable the completion of the abutment and four piers at the easterly end of Line 13, Plate CXXVIII, before they were moved. The south abutment of Hunter's Point Avenue Bridge, the small piers just east of the *B-D* portal and the *B-D* invert itself were all so close to the proposed temporary location of those tracks that it was expedient to construct as much of them as possible while the tracks remained in their original location. This condition fixed four points of attack, the abutments and piers above mentioned forming three and the easterly end of the *B-D* invert the fourth, and, since 90% of the rock excavation lay west of Van Alst Avenue, it was likewise desirable to open up that end of the work at once, which made a fifth point of attack. The tracks were put in service in their temporary location on May 11th, 1908, the piers and abutments mentioned having been completed with the exception that only the foundations could be built for the two southerly piers of the group of four near the *B-D* portal because their location was immediately under that of the tracks. The easterly 400 ft. of the *B-D* invert was likewise completed at that date, and the work west of Van Alst Avenue well opened up.

For convenience in handling, the work was divided into three sections, and each was put in charge of a separate superintendent, the work west of Hunter's Point Avenue forming the first, Hunter's Point Avenue Bridge and the tunnels underneath the second, and all work east of Hunter's Point Avenue the third.

The excavation west of Van Alst Avenue was made in open cut, the earth being excavated by a small Thew steam shovel and disposed of by horses and wagons on the northerly approach to Hunter's Point

PLATE CXXX.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.

INVERT APPROACH TO *B* AND *D* TUNNELS.

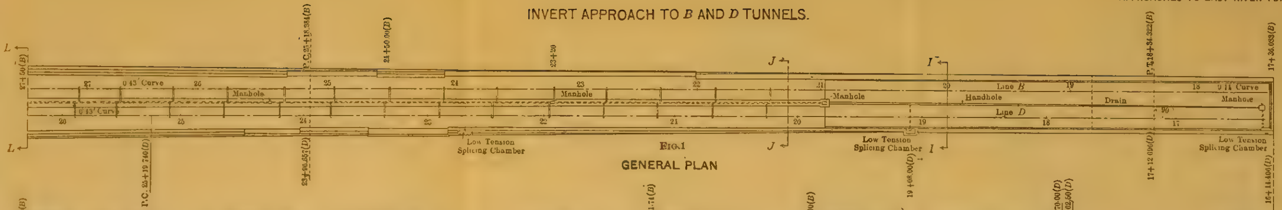


FIG.1

GENERAL PLAN

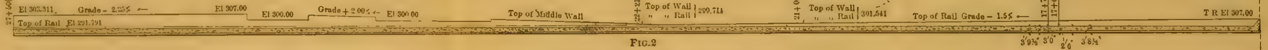


FIG.2

ELEVATION OF MIDDLE WALL

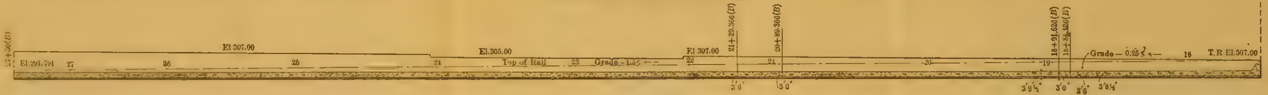


FIG.3

ELEVATION OF NORTH WALL.

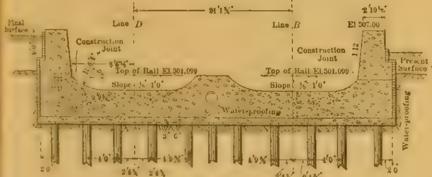


FIG.4

SECTION *JJ* AT STA. 21 + 29.404 (*B*)

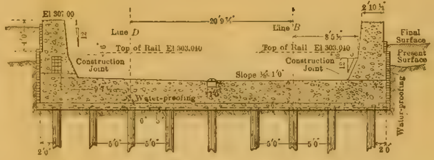


FIG.5

SECTION *I-I* AT STA. 20 + 00(*B*)

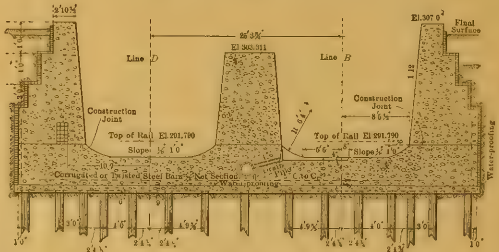


FIG.6

SECTION *LL* AT STA. 27 + 50(*B*)

Avenue and adjoining streets, where the material was used to bring their grade up to a new level made necessary by the construction of the tunnels and the alterations in the Long Island Railroad. That portion of the approach to the old Hunter's Point Avenue Bridge which lay above the general surface and had to be removed by reason of the increased length of bridge, was likewise removed by steam shovel, but all excavation, with the two exceptions just noted, was made in securely-sheeted trenches. That for the *B-D* invert and Tunnels *B* and *D* east of Hunter's Point Avenue will be described somewhat in detail, as it was typical of the whole work, and variations from it will be noted.

Lines *B* and *D,* as previously explained, approach the tunnels in a common invert, shown on Plate CXXX, although for a part of the length the lines are separated by a concrete wall.

The excavation for the invert varied from 49 ft. wide at the easterly end to 69 ft. at the portals, and in depth from 8 ft. at the former point to 22 ft. at the latter.

A line of piles, 12 ft. apart, was driven on each side of the proposed permanent construction and about 2 ft. outside of it, with two additional lines set so as to divide the excavation into three approximately uniform widths, as shown by Fig. 1, Plate CXXXII. To these piles the rangers and struts of the top set were bolted. The struts were 12 by 12-in. squared timbers, though in some of the later work round sticks were used. The top set of rangers was formed by two 8 by 12-in. sticks blocked apart sufficiently to form a slot for the sheeting, which varied in thickness from 4 to 6 in., depending on the depth of the excavation to be made. The piles described above were driven by a 2 000-lb. sheeting-hammer shown on Figs. 1 and 2, Plate CXXXII.

The timbers were set in place and the piles were delivered to the driver either by derricks, as in Fig. 1, Plate CXXXII, or by the travelers shown in the background on that photograph and at closer range on Fig. 1, Plate CXXXIII, in which the two travelers are standing back to back on their rails. All the derricks were supported on clusters of piles driven for the purpose, therefore, they could be erected very close to the side of the excavation, which gave them a greater effective radius than they would otherwise have had. Each traveler rail rested on short ties carried by two 12 by 12-in. stringers, supported by three pile bents every 10 ft., the piles being driven by the steam hammers subsequently described. These piles were in proper locations for the finished work, and, after the excavation was completed, those which did not have a proper bearing were driven deeper by the 2 000-lb. drop-hammer, after which all were cut off at the correct elevation and used in the permanent work.

The sheeting was set up and driven by the sheeting drivers before mentioned, which were moved along on rollers resting on the top set of struts. It was driven, before beginning the excavation, as deep as it would go and yet remain plumb; this was, in some cases, the entire depth required, and, in all other cases, through the swamp mud and into the underlying material. The use of heavy sheeting was of great advantage, on account of its ability to stand the driving and to span considerable lengths when it became necessary to remove struts during the concreting.

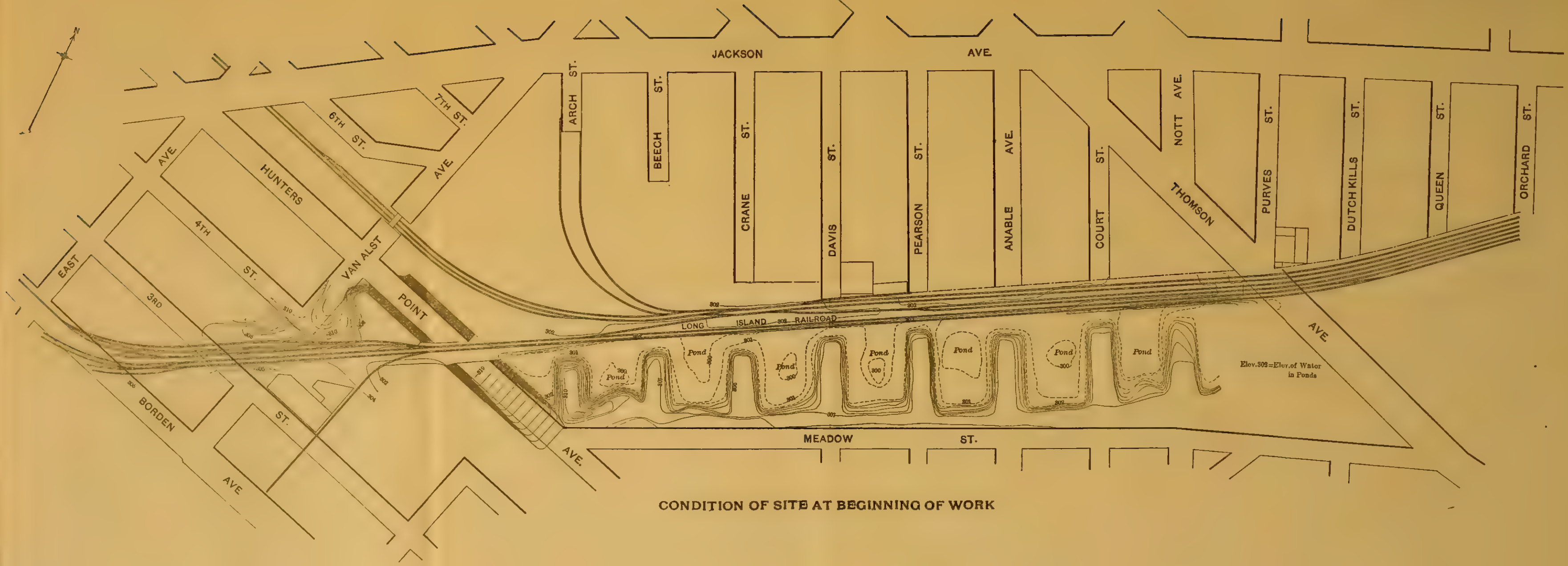
As previously stated, the entire *B-D* invert rested on a pile foundation, the bents being 5 ft. apart and the number of piles per bent varying from 9 to 15. For the easternmost 460 ft., where the depth of excavation was small and the material to be excavated of such nature that its presence at the time of driving would not affect the penetration, the piles were driven before excavating was commenced.

The excavating was done by ½-yd. and 1-yd. orange-peel buckets operated by the derricks or travelers, a few men being kept in the trench to shovel the material from under the struts and rangers to points where the buckets could reach it. The material was loaded into narrow-gauge dump-cars and such of it as was suitable was deposited in embankment for surface tracks or used for back-filling completed structures, while the swamp mud was wasted on low ground south of Meadow Street.

Additional sets of struts and rangers were placed at intervals of from 6 to 4 ft. as the excavation proceeded, the latter spacing being used toward the bottoms of the deeper portion of the trench.

Where the bottom, at the elevation of the base of the concrete, was so soft that it would churn up and become mixed with the concrete in placing, the excavation was carried from 1 to 4 ft. deeper, and the intervening space was filled with refuse from the rock excavation and dust from the crusher. The greater depth was used at all points where the excavation had not penetrated the swamp mud and was sufficient

PLATE CXXXI.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.



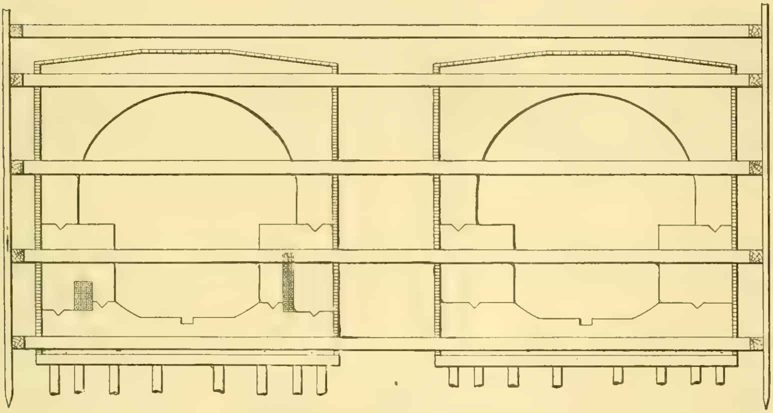
CONDITION OF SITE AT BEGINNING OF WORK

to form a blanket through which the mud did not work previous to the concrete being placed.

B AND *D* TUNNELS WEST OF PORTAL.

Although the two tunnels were built separately throughout most of the distance from the portal section to Hunter's Point Avenue, they were constructed in a single trench, the distance between them being so slight as to make the removal of the additional excavation less expensive than the driving of two lines of sheeting. The width of the trench varied from 57 to 67 ft., and the depth from 17 to 37 ft.

The methods of sheeting and excavating were similar to those described above for the invert, except that the travelers were not used, all the excavation being made by the derricks which, on account of the width of the trench, were alternated on its two sides.



ARRANGEMENT OF STRUTS.

FIG. 4.

The struts in all trenches for tunnels were placed at such elevations as would require the least number possible to be removed at each step of the construction, as shown on Fig. 4.

The entire excavation for Tunnels *B* and *D* was carried to a depth considerably below the bottom of the swamp mud, and much of it was carried to rock through material so firm as to require picking, after which, however, it was loaded into cars by the orange-peel buckets before described.

Portal Section.

The construction of the *B-D* portal was commenced at about the same time, and was carried on simultaneously with that for the invert. The excavation was somewhat wider than that for either tunnels or invert, the additional room being required for the pump chamber and sump, and, as it was intended to complete the portals to the top of the tunnel bench before proceeding with the excavation east or west of them, it was sheeted on all four sides, and the timbering varied considerably from that described for the invert, as shown by Fig. 2, Plate CXXXII. The framing was done in rectangular 10 by 12-ft. bays of 12 by 12-in. timbers, and the sheeting was 8 by 14-in. with a tongue and groove formed by 1½-in. or 2½-in. strips firmly spiked to the main timbers.

The location of the portals brought a part of the excavation within the limits of the fill for Crane Street. This was removed to the general level of the swamp, the rangers and struts of the top set were then set and temporary piles for supporting them were driven at each intersection, as shown by Fig. 2, Plate CXXXII, after which the sheeting was set and driven through the swamp mud. Excavation was then commenced with one of the orange-peel buckets operated by a derrick. Fig. 2, Plate CXXXII, gives a good idea of the nature of the material and the length of sheeting remaining to be driven during the excavating. Additional tiers of struts and rangers were set at intervals of about 5 ft.

The effect of continuing to drive piles after they have reached rock was clearly shown when the earth excavation for these portals was completed. Piles were furnished the timber foreman in charge of this excavation, of a length somewhat greater than necessary to reach rock at the elevation indicated by the borings, and he was instructed by the superintendent of the work to drive them to rock. The machine used was one of the 2 000-lb. sheeting-hammers before mentioned. The foreman reported that he had driven the piles as far as possible without bringing their tops below the upper set of timbers which they were intended to support and had not reached rock, which must be deeper than anticipated. Figs. 1 and 2, Plate CXXXV, show what actually occurred, the bottoms of practically all the piles being similar to those here shown, and a glance at Fig. 2, Plate CXXXII, will show that the

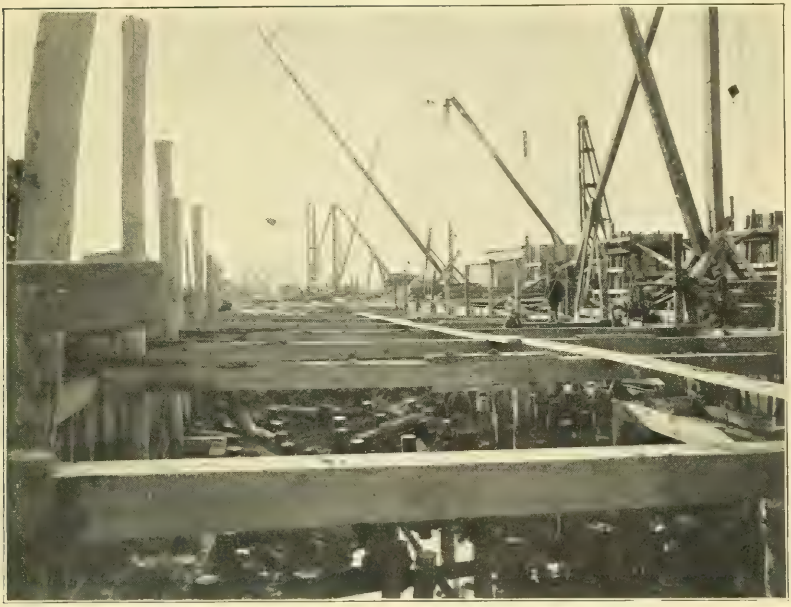


FIG. 1.—TIMBERING OF *B-D* INVERT.

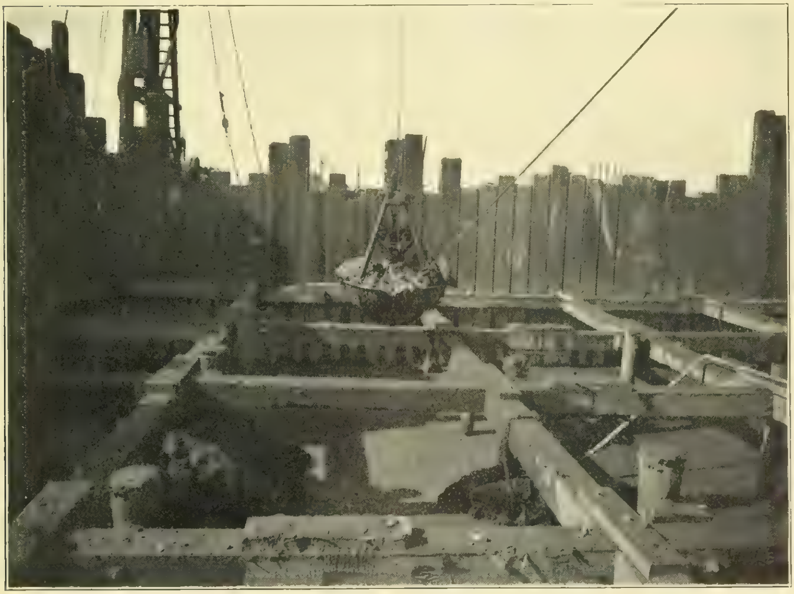


FIG. 2.—TIMBERING FOR *B-D* PORTAL.

tops were not badly broomed. Unfortunately, no record was made of the amount or rate of penetration of these piles or of their actual length before driving, as they were not a part of the permanent work, but the foreman insisted that they all moved very uniformly up to the time he stopped driving.

LINE *A* INVERT AND TUNNEL.

The excavation for Line *A* invert and tunnel east of Hunter's Point Avenue was very similar to that described for *B-D*, with the exception that, being for a single line, it was much narrower, 30 ft. at the easterly end and 44 ft. at the widest point.

HUNTER'S POINT AVENUE VIADUCT.

The excavation for Hunter's Point Avenue Viaduct and the tunnels underneath was made in four trenches. Trench No. 1 was for the south abutment alone, and was 196 ft. long, 30 ft. wide, and varied in depth from 16 to 30 ft. The timbering was similar to that described for the *B-D* invert, the top set being shown by Fig. 1, Plate CXXXVI, together with the location of two stiff-leg derricks which covered the entire excavation. Excavation No. 2, in the order in which they were made, was for Tunnel *A* and the north abutment, the two structures being a continuous block of concrete, although not a monolith from foundation to bridge seat. This excavation was 176 ft. long, 51 ft. wide at all points, except for the wings of the abutment, and the depth from the general surface to rock was from 18 to 44 ft., which, except at the extreme easterly end, was above the proper elevation for the foundation of the tunnel, and, therefore, required that the rock be excavated for the width of the tunnel and for a depth varying from 0 to 9 ft.

There was a slight variation from the general method in the procedure at this excavation, due to the site being partly occupied by the northerly abutment of the old overhead bridge previously mentioned. It was founded on piles about 3 ft. below the level of the general surface, and was removed and the entire excavation made to that depth before any timbering was placed. Two sets of rangers and struts were then laid, the first on the bottom as excavated, and the second posted 5 ft. above, after which the sheeting was set and driven about 5 ft. below the lower set of rangers and carried down as the excavation proceeded.

The third excavation was 142 ft. long and 58 ft. wide, and included the three southerly piers and Tunnels *B* and *D*. The fourth excavation, for the northerly pier and Line *C* invert, was shallow, as the foundation was on piles at an elevation of only 8 ft. below the general surface, and was made between the southerly sheeting of Trench No. 2 and the northerly sheeting of Trench No. 3.

CONCRETING.

In building concrete the following general principles were adhered to: that all concrete sections for piers and abutments should be monoliths above the level of the surrounding grade; that tunnels and inverts should be monolithic as nearly as practicable; and that the length of sections in continuous structures should be approximately 50 ft.

SEQUENCE OF OPERATIONS.

On all invert work resting on piles, three concreting operations were necessary; the first was the concrete base for water-proofing, which was 9 in. thick, 3 in. about the heads of the piles and 6 in. over them; the second comprised the floor from the water-proofed base to the elevation of the bottom duct; the third was the construction of the side-walls. For 346 ft. of the westerly portion of *B-D* invert, where the distance from the bottom duct to the surface of the ground was greater than 11 ft., it was not considered safe to remove all struts, and the side-walls were built in two lifts, making a total of four operations. The limits of these several operations are shown on Plate CXXX by lines marked "construction joints."

The tunnels were built in three operations above the rock foundation, or water-proofing, where not founded on rock; the first was the floor and side-walls up to the level of the ducts; the second was the bench-walls; the third was the arch. In the north abutment for Hunter's Point Avenue Bridge, built in conjunction with Tunnel *A*, these levels were carried right through the abutment, and the final lift, above the top of the tunnel arch, was built as a monolith. At the crossing of Tunnel *C* over Tunnel *B*, west of Hunter's Point Avenue, the third operation of Tunnel *B*, namely, the arch, included the floor of *C* up to the duct level, leaving two operations for Tunnel *C* proper, and making five for the two tunnels. These "construction joints" are shown on Figs. 1, 2, and 3.

PLATE CXXXIII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.

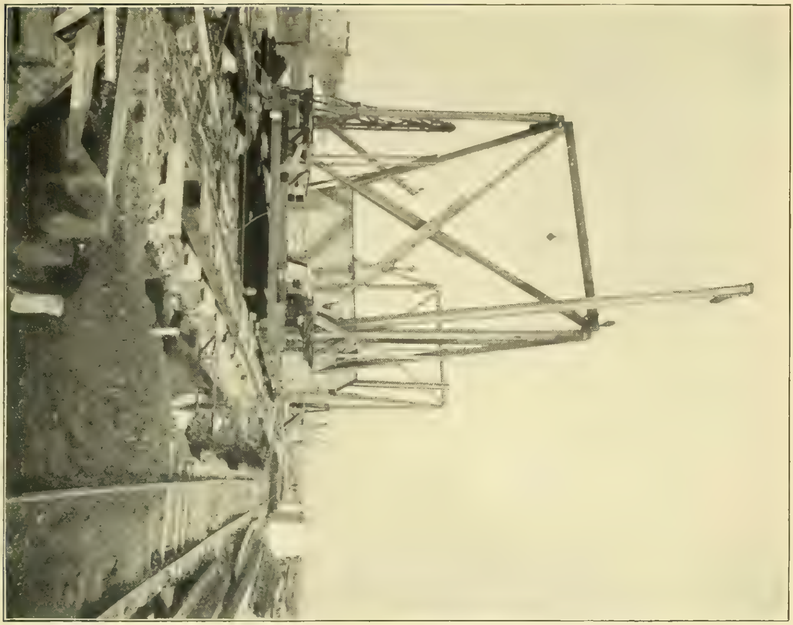


FIG. 1.—TRAVELER USED ON *B-D* INVERT.

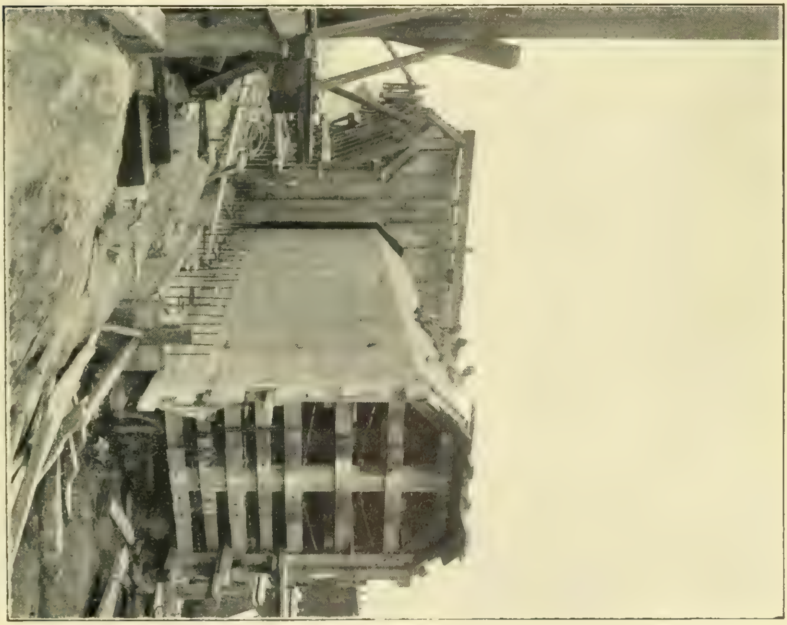


FIG. 2.—FORMS FOR CONCRETE APPROACH TO OVERHEAD TRACK BRIDGE.

The forms for the first lift, or water-proofing base, were very simple, consisting of a 10-in. plank along each side, braced from the sheeting so as to form a ditch for carrying off the water, and a bulkhead of the same height at the end of the section. Steel rods, of ½ sq. in. net section, were then placed resting directly on the piles, longitudinally, crosswise, and on both diagonals. These rods were intended to bind the entire mass together and prevent the piles from pulling the slab apart if subjected to lateral pressure from mud waves.

The concrete was delivered in 2-yd. Stuebner buckets, handled by derricks and dumped by laborers standing on the prepared foundation, no handling of the concrete being necessary after it was dumped, excepting ramming and spading about the piles and steel rods. A surface sufficiently smooth for the water-proofing was obtained by patting the concrete with the flat of the shovel; where an occasional point of stone showed through, after the base had hardened, it was picked out and the void filled with mortar.

The next step was to build the brick protecting wall for the water-proofing to a height at least up to the level of the duct bench. Where necessary to make room, as was the case in the section shown by Fig. 1, Plate CXXXVII, the lowest set of timbers was first removed, the thrust being taken by the 9-in. water-proofing base.

Forms for supporting the brick wall were built in sections, from 12 to 20 ft. long and from 4 to 6 ft. wide, of 2-in. planking securely spiked to 4 by 6-in. posts, and were easily swung about from place to place by the derricks and quickly set up and braced to the sheeting. They are shown extending slightly beyond the brick wall in Fig. 1, Plate CXXXVII. The brick wall was 4 in. thick, and a fillet of mortar was formed at the junction with the concrete base, as it was found impossible to tuck the water-proofing into an absolutely square corner and keep it there.

The water-proofing, of six ply of felt and seven of pitch, similar to that described in previous papers of this series, was applied in two sheets of three layers each and in three lengths. The first sheet of three layers was laid on the base extending from brick wall to brick wall, as shown by Fig. 1, Plate CXXXVII, each strip lapping 2 ft. over the previous strip. A sheet of three layers was then applied to each brick wall, the strips running vertically and breaking joints in a manner similar to those in the base sheet, over which it lapped at least 1 ft. The second sheet of three layers was then laid on the base, lapping 1 ft. over the ends of the vertical strips, and was followed with the sheet of three additional layers on the brick walls, laid as before described.

It can be noted by referring to the "construction joints" shown on Figs. 1, 2, and 3, and Plate CXXX, that the floor sections, as built, included the side-walls up to the duct-bench for plain floors, and for floors with fillet included the entire fillet, which extended from 0 to 9 in. above the level of the bottom ducts, and necessitated a step down, of that amount, just in front of their location.

The forms for the few inches of side-wall built in conjunction with the plain floor consisted simply of a square timber with one side cut to form the batter of the wall. The forms for the fillet were built up in 26-ft. lengths, so that two lengths would serve for one side of a 50-ft. section and lap on the finished work. These forms are shown by Fig. 5. They were supported at one end on the finished work, at the other on the timber bulkhead at the end of the section and at four or five intermediate points on concrete pillars previously moulded for the purpose, and indicated in dotted lines on Fig. 5, and were further held in position by vertical and diagonal braces from both sides of the forms to the struts above. The drain form, likewise shown on Fig 5, was similarly supported. Each section contained two large iron rings by which it could be lifted vertically by the derricks. In that portion of the *B-D* invert having a center-wall, four lines of the fillet forms were necessarily required. The drain, a 15-in. vitrified pipe in the floor under the center-wall, was laid as the concrete was placed, and wired up to and braced down from the struts above. Fig. 2, Plate CXXXVII, shows the first section of invert floor of this type built. At the time this photograph was taken the fillet forms had been removed and are seen lying loose, the section had been back-filled up to the level of the duct-bench and the top set of timbers had been removed preparatory to moving the side-wall forms ahead. These forms are seen in the background, where the preceding section of side-wall is being concreted. These forms and those for the bench-walls of the tunnels were very similar, those for the tunnels being shown by Fig. 6. They were very solidly constructed, and the bolts and wedges (shown by Fig. 6) permitted their adjustment to the curves to a nicety, and enabled them to be slacked off readily for moving

PLATE CXXXIV.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.

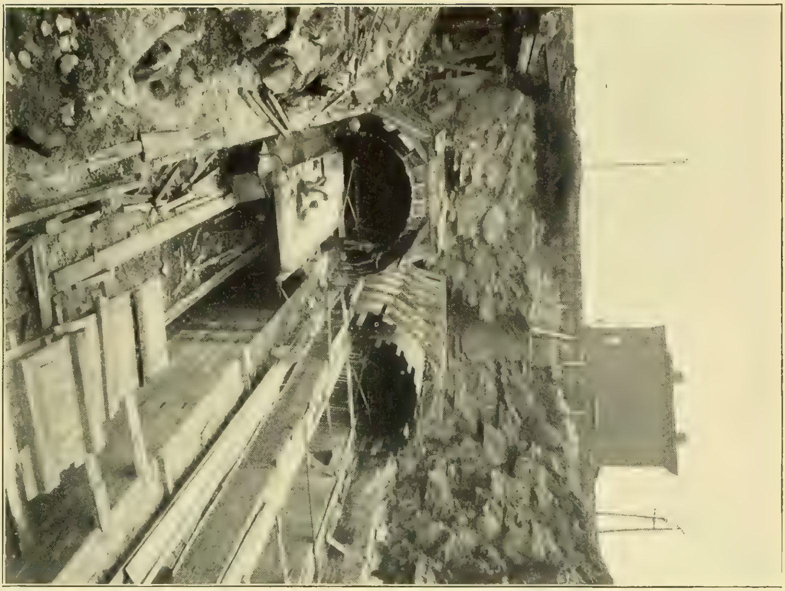


Fig. 1.—Tunnels *A* and *B* in Rock, Showing Arch Forms.

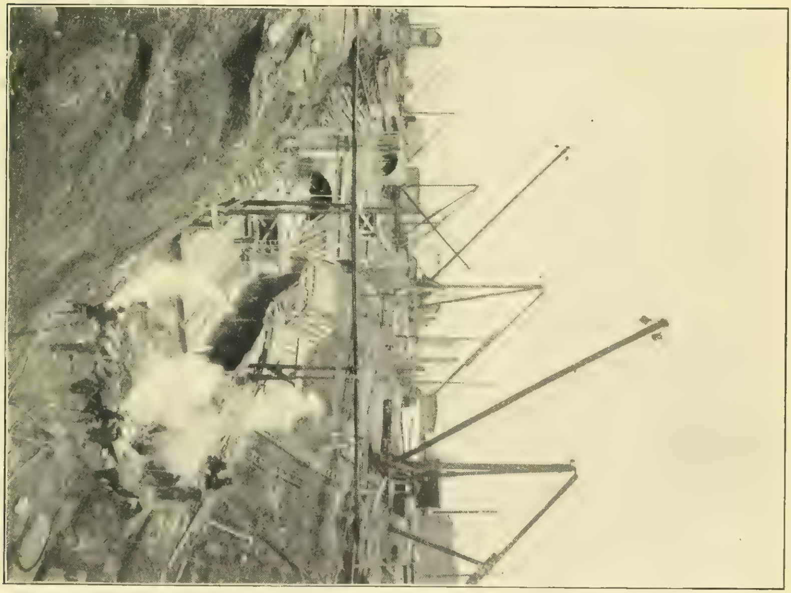
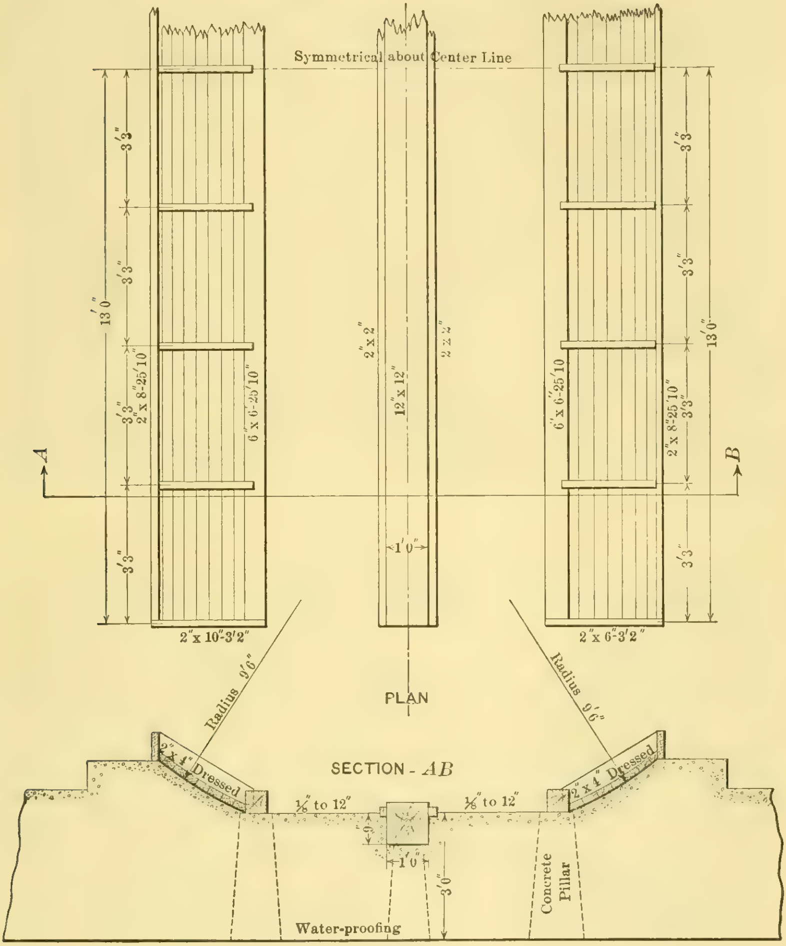


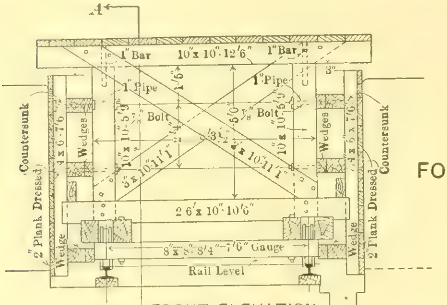
Fig. 2.—Tunnel *C* Crossing Tunnel *B*.



FORM
FOR
INVERT AND DRAIN IN TUNNEL SECTION IN EARTH

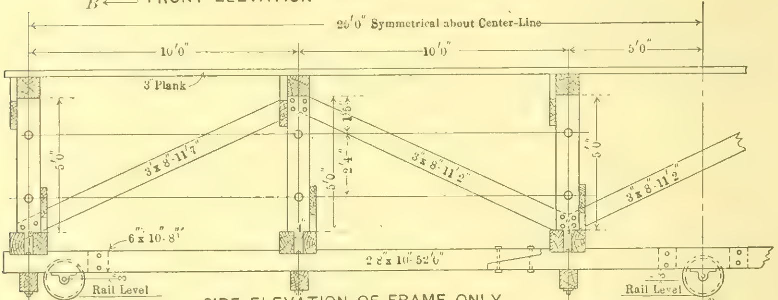
FIG. 5.

ahead from section to section. They were built in 52-ft. lengths, so that one end was constantly engaged by the finished work. They traveled on 70-lb. rails laid on stringers on the floor of the tunnel, being pulled ahead by a block and fall operated by one of the derricks, and, when in position for concreting, were blocked free of the rail.

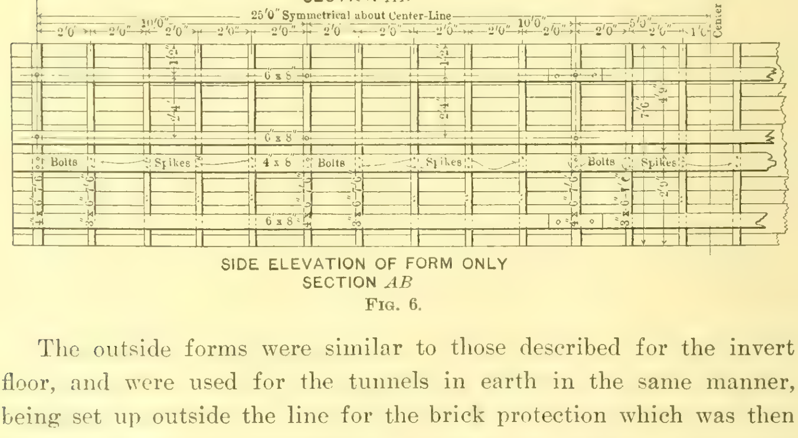


FORM FOR SIDE-WALLS OF TUNNELS

FRONT ELEVATION



SIDE ELEVATION OF FRAME ONLY
SECTION *AB*



SIDE ELEVATION OF FORM ONLY
SECTION *AB*

FIG. 6.

The outside forms were similar to those described for the invert floor, and were used for the tunnels in earth in the same manner, being set up outside the line for the brick protection which was then built and water-proofed before the concrete was placed. For the in-

PLATE CXXXV.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.

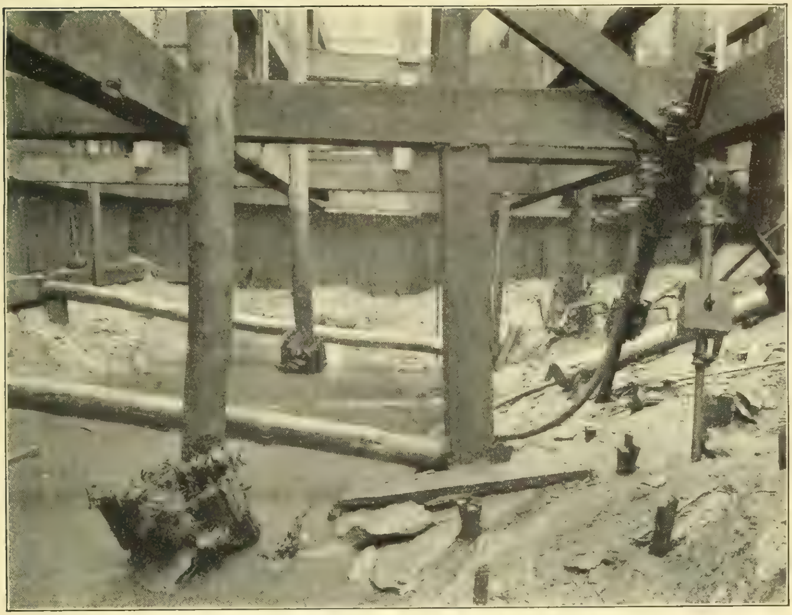


Fig. 1.—Piles, Showing Result of Too Much Driving.

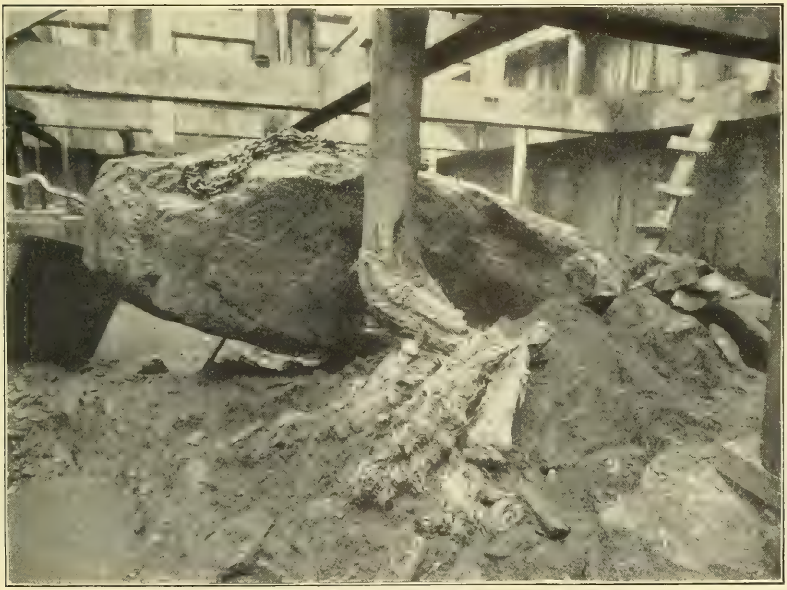


Fig. 2.—Piles, Showing Result of Too Much Driving.

verts, the back forms above the duct-bench were set on the line of the back of the concrete, and the water-proofing and brickwork were placed subsequently. This was necessarily so, as the backs of the inverts stepped in at each 4 ft. of rise, and the brickwork above the first step had nothing on which to rest until after the concrete was built.

The ducts for electric cables were sometimes laid before the bench-wall forms were moved ahead, and sometimes afterward, but were in all cases allowed to set before the concrete was deposited about them.

The arrangement of the ducts is shown by Figs. 1, and 2. They were of only two kinds, low-tension, and telephone and telegraph, the former being single and the latter four-ways. The ducts themselves and the methods of laying have been described in previous papers of this series.

The concrete was delivered in Stuebner buckets by the derricks, as described for the floor, but was not dumped in the form, but on the platform over the carriage, and shoveled from there into the form, care being required to keep it at all times at the same level at the back and in front of the ducts, as they were easily pushed out of line. This was particularly true of the four-ways which stood in a single tier six high. Two men in each bench-wall kept the concrete well rammed and spaded. After the ducts were covered, the concrete was dumped directly into the forms, and little shoveling was necessary.

The arch forms were built in sections of the same length as, and supported on, though not attached to, carriages similar to the bench-wall forms. The carriage and forms are shown by Fig. 7. The ribs, 4 ft. 6 in. from center to center, were made of two 5 by 3 by $\frac{3}{8}$-in. angle irons, placed back to back and separated sufficiently to admit the braces. They were hinged at a point 3 ft. $3\frac{1}{4}$ in. above the springing line of the arch, which was itself 2 ft. $8\frac{1}{4}$ in. above the bench, and the end sections of the bottom chord, being hinged at the junction with the arch rib and bolted at the inner end, could be removed and the whole lower section of the form pulled into the position shown in dotted lines on Fig. 7 when it was desired to slack the arch.

The arch ribs rested on and were securely bolted to 8 by 12-in. timbers laid flat and parallel to a 50-ft. chord of the tunnel curve, the arch and ribs being radial, with their ends parallel to the curve. The sheeting was of $2\frac{1}{2}$ by 4-in. yellow pine, cut to the curve of the intrados, with radial edges, and was bolted with stove-bolts to the arch ribs. The forms were blocked into position with wedges between the longitudinal timbers mentioned above and similar timbers bolted to the top of the carriage, and also from blocking resting on the bench-walls near the outer ends of the lower chords.

The most economical procedure was to have a sufficient length of floor concreted ahead of the bench, and the bench ahead of the arch, to enable the forms to be moved in their regular order, but the room for receiving excavated material was so limited that at times it became expedient to carry the arch even with the completed bench; in which case the arch forms were run ahead on pipe rollers and blocked up on the platform of the bench-wall carriage. The bench-wall carriage was pulled ahead for the next section of bench when desired, the arch form being left blocked up on the completed bench-wall, and its own carriage was shoved under it for the subsequent move.

The outside forms above the bench, for tunnels in earth, were similar to those described for the floor and bench-wall, but were built in sections of the same height as the vertical height of the tunnel above the bench-wall.

The concrete was dumped from the buckets before described on the crown of the arch form and with little assistance slid into position, where it was rammed and spaded into a compact mass by two men on each side of the arch. After the concrete had reached the crown of the arch, the buckets were dumped at different points over the entire section, and shoveling was thus avoided.

TUNNELS IN ROCK.

The construction of tunnels in or on rock varied somewhat from that described for tunnels in earth, the amount of variation depending on the elevation of the original surface of the rock with reference to the floor of the tunnel. The variations, however, can be classed under three headings: tunnels resting on rock, but not in rock excavation; tunnels built in rock excavation, the original surface of which was below a line 5 ft. above the bench-wall; and tunnels in rock excavation, the original surface of which was above that line.

For tunnels resting on rock foundation, but not in rock excavation, the various steps were the same as for tunnels on pile foundations, except that, as the floor was not water-proofed, no sub-floor

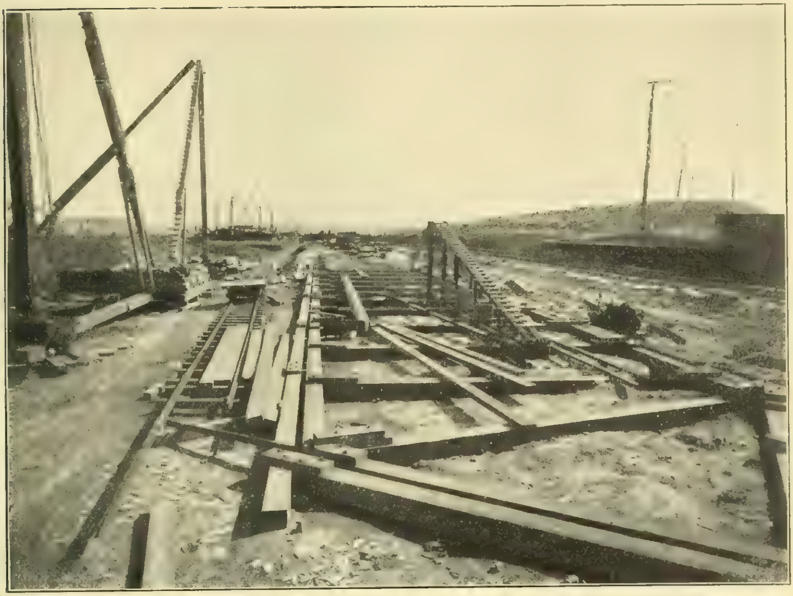


FIG. 1.—SOUTH ABUTMENT OF HUNTER'S POINT AVE. BRIDGE, SHOWING FRAMING OF TOP SET OF TIMBERS.

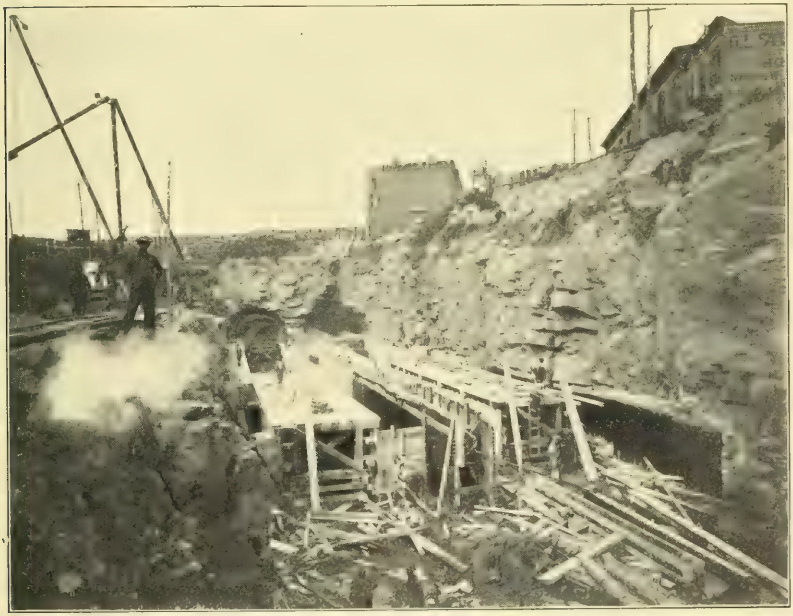
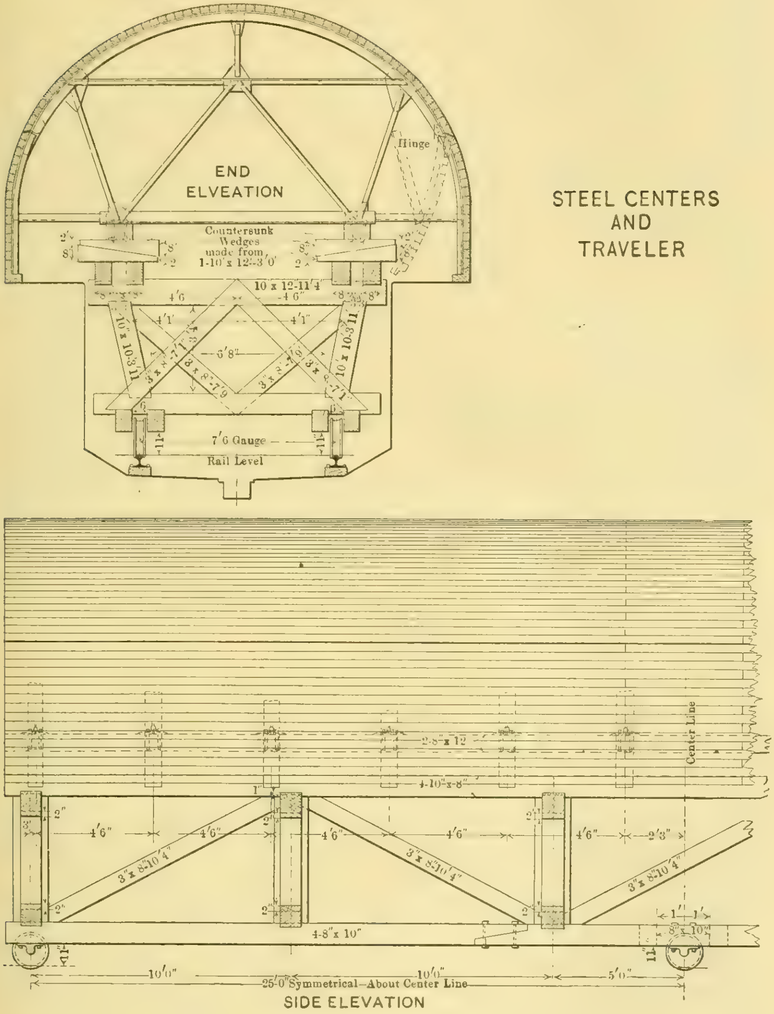


FIG. 2.—TUNNELS *A* AND *B* IN ROCK, SHOWING BENCH-WALL FORMS AND WATER-PROOFING.



STEEL CENTERS
AND
TRAVELER

FIG. 7.

was required, and the first operation was the building of the brick protecting walls for the water-proofing of the benches. In some cases where the rock, on which the tunnels were to rest, was more than 2 ft. below the finished floor, concrete was deposited up to that level before the brick walls were started. When the water-proofing was placed on the brick protecting walls, it was carried down to their base, and, as the concrete for the floor proper was being deposited, the bottom 6 in. of the entire six laps was turned up and the concrete rammed in under and about it, thus forming a seal to prevent water from rising between the concrete and the water-proofing and finding a joint through which to work into the tunnel.

Where tunnels were in rock excavation, the first step was to build sand-walls of concrete, filling the entire space between the water-proofing line and the sides of the rock excavation. Where the surface of the rock was below the level of the top of the bench, the sand-walls were built for the full height at one operation, but, where the rock was high, two or more operations were required, as it was difficult to force the concrete down so narrow a space, if of considerable height, the sand-walls varying in thickness from practically nothing to 3 ft., and also because it was difficult to attach the water-proofing to a sheer height and keep it there for the length of time that must elapse between the beginning of the construction of the floor and the completion of the arch.

The forms for the sand-walls were the same as those used for the brick protecting walls, and were held in place by raker braces from the bottom of the cut, or, for the upper lifts, from the completed bench-walls.

Fig. 2, Plate CXXXVI, shows Tunnels *A* and *B*, with sand-walls on the south side of *B* and the north side of *A*, and brick protecting walls on the adjacent sides of the two tunnels. It can be noted that the water-proofing on the brick walls is tacked to the forms above the brickwork to prevent it from slipping; the strips of wood shown on top of the water-proofing on the sand-wall are for the same purpose, these being tacked through the water-proofing to similar strips which were embedded in the concrete when the wall was cast. When it was desired to continue the sand-walls or brick protecting walls higher, the strips were pulled off, and the loose laps of water-proofing were laid back on the finished bench-walls, and after the additional height

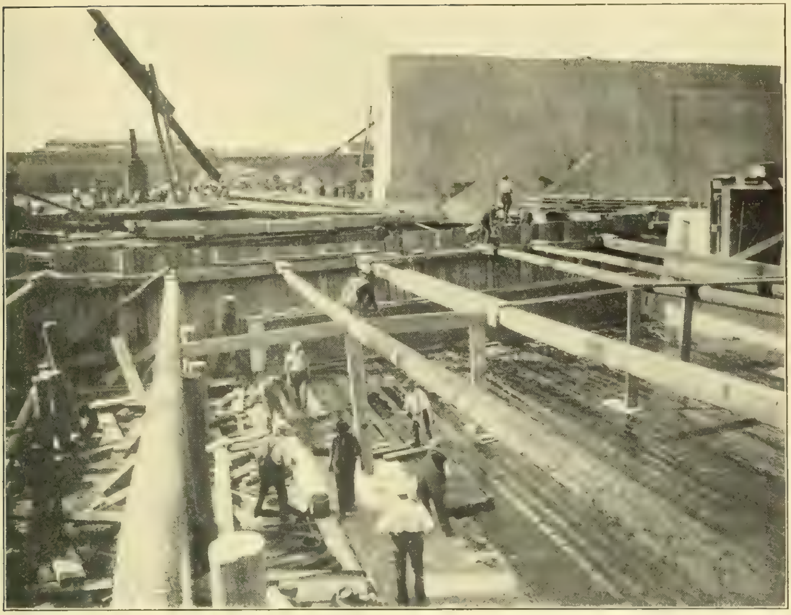


FIG. 1.—*B-D* INVERT. SHOWING WATER-PROOFING.

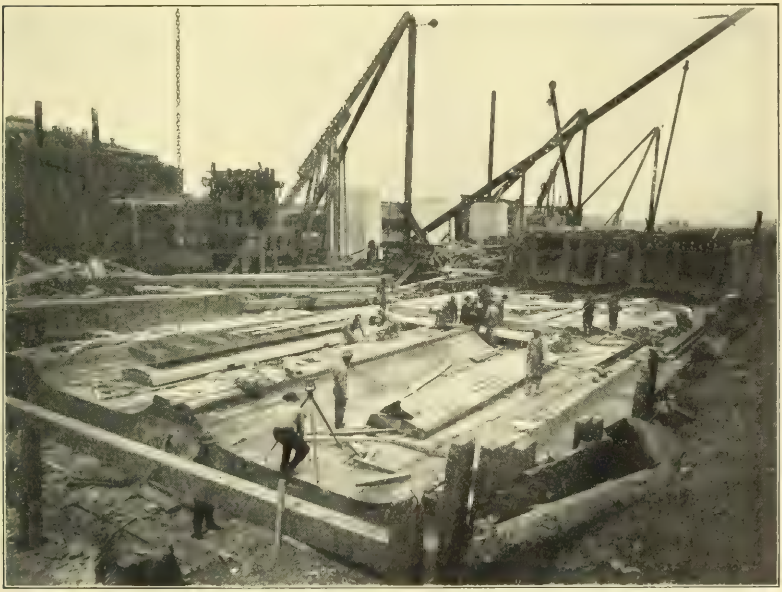


FIG. 2.—*B-D* INVERT, SHOWING FLOOR SECTION AND FORMS.

of wall had been constructed, one sheet of three thicknesses of the water-proofing was then attached to the new wall. The first sheet of three thicknesses of the upper lift having been brought down and lapped over them, the remaining laps from the lower lift were raised and pitched to the wall, and the last three thicknesses from the upper lift were then applied. It was found very difficult to prevent the lower sheets from sagging after this had been done, particularly in warm weather, although they were braced as soon as possible after the operation was completed, and, during the later stages of the work, better results were obtained by cutting the water-proofing off just back of the strips, allowing the strips and the water-proofing under them to remain and be concreted in with the next lift of sand-wall and lapping the entire six-ply from the upper lift 1 ft. over the joint. This, of course, could not be done with the brick walls, and bracing had to be depended on to hold the water-proofing in place, which, however, was not a serious matter, as the brick walls, usually, were not continued until after the arch forms were in place, so that concreting followed promptly the application of the upper lift of water-proofing.

The greatest variation, from the forms and methods used for tunnels in earth, occurred where the rock was of sufficient height to form abutments and develop arch action in the tunnel, and its roof was a true arch section, as shown on Section No. 1 of Fig. 1. The forms for this type of arch were similar to those previously described, with the exception of the outer forms for the arch proper. These forms are shown by Fig. 1, Plate CXXXIV, the form on the left being ready for concrete and that on the right in process of construction. Each bent, though securely bolted together, was little more than a template, and was not depended on to take the thrust from the wet concrete, the forms being firmly braced from the sides of the cut or adjoining arch. When being moved, the sheathing was knocked loose from the bents, and they were moved ahead and set up separately, after which the sheathing was replaced to the height shown in the photograph, about level with the intrados of the arch at its crown, the remainder being placed just ahead of the concrete, so as not to curtail the working space.

The crossing of Tunnel *C* over Tunnel *B* introduced special sections and therefore required special forms. Where the tunnels approached each other from the west and Tunnel *B* was entirely in rock excavation and Tunnel *C* either required rock excavation or a slight thickening of the floor to reach the rock foundation, the special form work was slight. Fig. 1, Plate CXXXVIII, shows the arch of Tunnel *B* and the floor of Tunnel *C* at the most westerly joint section, together with a sub-base for the next easterly section of Tunnel *C* built in conjunction with the southerly sand-wall for Tunnel *B*.

The special forms required where Tunnel *C* leaves Tunnel *B* on the north are clearly shown on Fig. 2, Plate CXXXVIII, they being completed ready for concrete, as is the arch form for Tunnel *B*, the top of which shows in the foreground. The forms for the jack-arches were built in position and ripped apart at each move, 5 by 7-ft. openings being left between them, through which the material could be passed ahead. The rock underlying Line C at this point varied from 3 to 14 ft. above the base of Tunnel *B*, and the construction of the floor and side-walls of the latter was identical with that of the single tunnel, the entire jack-arch construction and the floor of Tunnel *C* being concreted with the arch of Tunnel *B*. Fig. 2, Plate CXXXIV, shows the relative position of the tunnels just west of the jack-arch construction, the rock on which the jack-arches rested being shown to the right of the uncompleted portion of Tunnel *B*.

The cellular construction extended to within 97 ft. of the portal, from which point to the portal the viaduct support, mentioned in the description of the design, was used. In this construction the arches were built separately from the floor of the tunnel, and formed a sub-base on which water-proofing was laid similar to that described for tunnels on pile foundations, the entire construction varying from that of a tunnel on piles only in the substitution of the concrete viaduct for the piles.

The portals of the tunnels, although very simple in appearance when completed (as shown on Fig. 1, Plate CXXXIX), required an immense amount of carpenter work, as can be readily seen by an examination of Plate CXXIX, showing a few sections of *B-D* portal, which, on account of the two tunnels, is somewhat more complicated than that for either Tunnels *A* or *C*. This portal section was 38.5 ft. long, and included: a length of 14 ft. of tunnel, measured at the elevation of top of rail, the face of the portal being on a batter of 1 in. to the foot; 24.5 ft. of invert; three sets of stairs, each joining

PLATE CXXXVIII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.

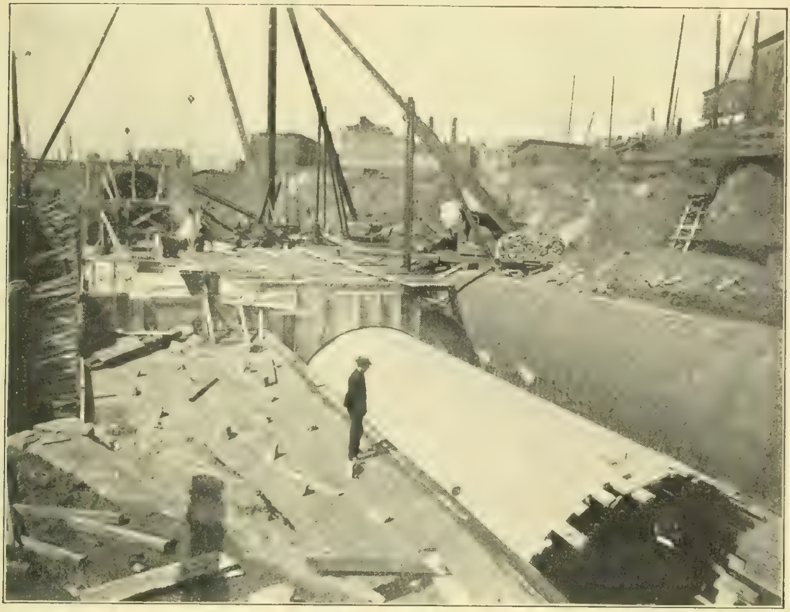


FIG. 1.—TUNNEL *C* CROSSING TUNNEL *B*: WEST END.

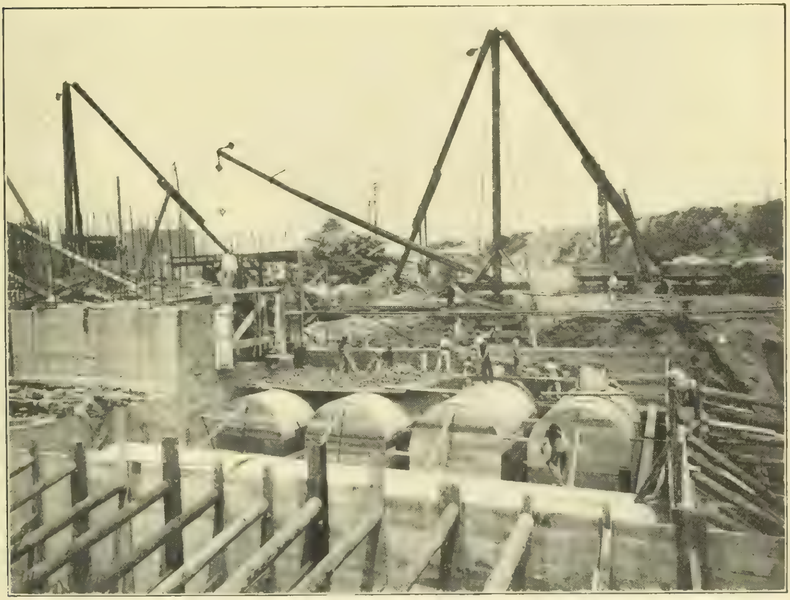


FIG. 2.—TUNNEL *C* CROSSING TUNNEL *B*: EAST END.

the roof of the tunnel, the top of the invert wall, the tunnel bench-wall, and the floor of tunnels; two sumps of arch and invert form, 8 ft. wide, 9 ft. high, and 63 ft. long; two 9 by 17-ft. pump chambers; one large manhole at the outlet of the drain to the sump; two splicing chambers; one telephone tower, for bringing the cables to the surface; and numerous openings for pump suction and discharge pipes, cables, etc.

The concrete was placed in four operations, the first including all concrete below the level of the duct-bench, the second the tunnel-bench and the steps leading from that bench to the tunnel floor, the third including the side-walls of the inverts, all remaining stairs, and the pump chambers above the floor, at which stage the photograph, Fig. 2, Plate CXXXIX, was taken, and the fourth the tunnel arch.

The details of the form work would be of little interest, but a few points will be mentioned. The sump forms were built in sections at the contractors' shop, and required only to be joined together after being lowered into the excavation, where they were supported on bolts which had been concreted into the rock floor. They were prevented from moving sidewise, by being braced apart and from the sides of the excavation, which braces were removed as the concreting proceeded; and from rising by being filled with water above the level of the concrete as it advanced. The stair forms as first erected consisted of risers only, the treads being placed after the riser was full of concrete. The arch roof of the portal was not built until after the bench-wall to the west had been completed and the regular tunnel centers had been erected.

Care of Spring-Water.

Many springs were encountered in the rock excavations, and, as the water had considerable head, great care was required to handle it so as to prevent it from washing the cement out of the concrete floors and leaving them porous. The usual method was to build a small brick inverted sump over the spring and lead it through a pipe (which was concreted in) to some point outside the section. One of the largest springs was in the last section to be concreted in Tunnel *B,* near Station 36 + 60. The usual methods were tried, but, probably due to this being the last section, which required the water to rise in the pipe slightly above the level of the finished floor before it could run off, there were three springs through the floor of the concrete after it had set. The porous concrete was cut out about these points, and pipes were set and grouted in the floor, the flow being thus confined to the pipes. After the grouting had thoroughly set, the pipes were plugged temporarily, but this was followed by leakage from the expansion joints on either side of them. The leakage formed quite a stream at several points below the level of the bench-wall and at the bench-wall, and in one of the joints produced moisture as high as the crown of the arch. When the plugs were removed from the pipes, the leakage at the expansion joints subsided and finally ceased entirely. The flow from these three pipes, aggregating about 5 000 gal. of water in 24 hours, is allowed to find its way to the sumps through the drains provided for that purpose.

It was found in a number of instances that the seal before described at the bottom of the side-wall water-proofing was not quite effective, and small streams of water were discovered rising to the level of the duct-bench between the water-proofing and the concrete. These were cared for much in the same manner as the springs in the rock, by pipes set in grooves cut in the duct-bench and leading the water to the drains. After the tunnels were completed, these pipes were plugged temporarily, and, if the water did not then find an outlet into the tunnel at some other point, they were grouted, but in a few instances it was found necessary to allow them to run.

There were many small springs in the excavation for the *B-D* portal, and, on account of the great number, the low points in the rock were filled with concrete before the forms were set, in order to crowd out as many of the springs as possible and combine others. The remaining flow was then conducted through grooves, cut in the concrete and rock and covered with sheet iron, to a sump near the northeast corner of the excavation. The result was very good, as far as caring for the water during concreting was concerned, but, after the concrete was placed to the duct-bench level and the back-filling was completed to a point about 2 ft. below that level, a large stream of water found its way between the concrete and the water-proofing and rose to the floor level, 2 ft. above the back-filling, where it poured out over the top of the water-proofing then in place. No attempt had been made to seal the bottom of the water-proofing, as was subsequently done, and it was found necessary to dig down and remove about 6 in. of it and form a seal with brick.

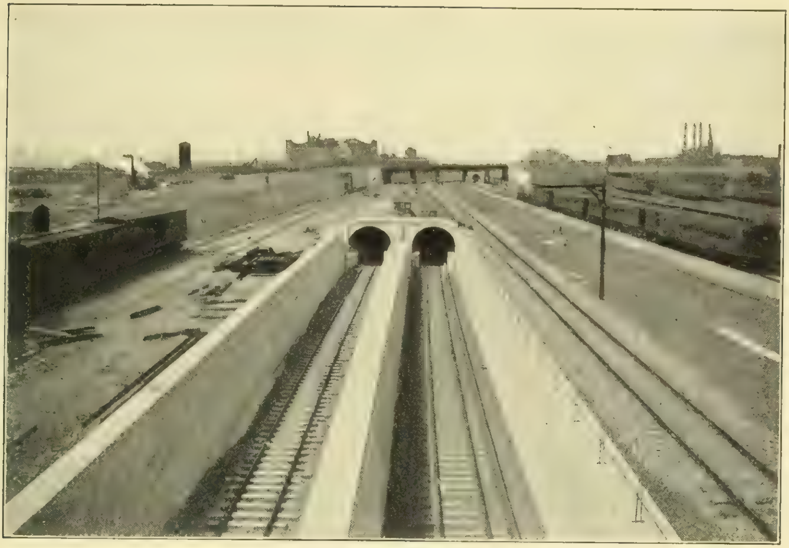


Fig. 1.—Portal of Tunnels *B-D*.

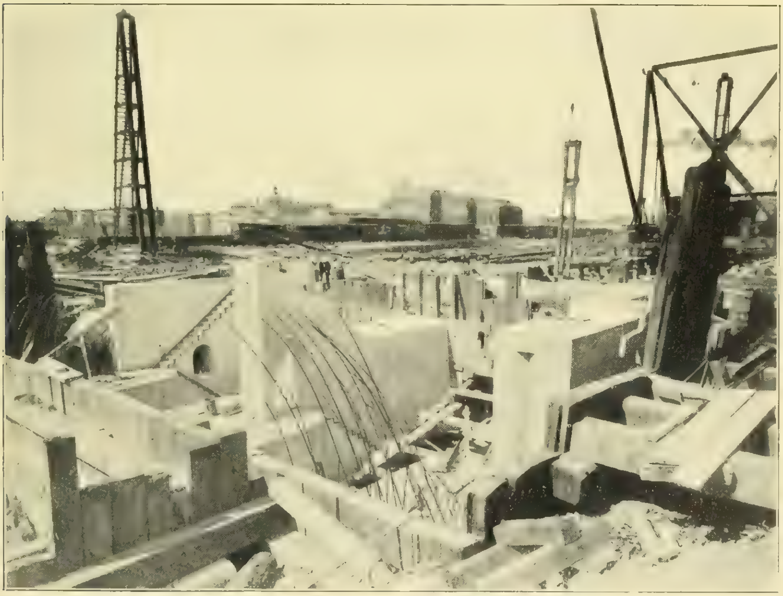


Fig. 2.—Portal of Tunnels *B-D* Before Constructing Arch.

Construction for Overhead Tracks.

At the time the small piers for Line 13 were constructed, it was anticipated that some movement would occur in them when the filling for the surface tracks was made about their bases, and, to prevent individual piles from moving at different rates and being broken or torn loose from the pier they supported, the sheeting was left in place. The tendency to move was not over-estimated, as a difference in elevation of 2 ft. on opposite sides of a pier, even if none of the fill touched it, caused movement away from the fill, which, however, was readily counterbalanced by placing a slight excess of fill on the opposite side. The maximum movement noted in any of these piers was 1⅝ in., and the maximum variation from the original position at the completion of the fill was ⅝ in.

The original plans for the approach to the double-track viaduct for the overhead freight line contemplated an earth embankment supported by two gravity retaining walls resting for most of their length on piles. The action of the small piers noted above made it plain that it would be, not only expensive, but difficult, to construct the walls, where the embankment was high, so as to keep them in their original position. The grade and location of the adjoining tracks were such as to permit the earth embankment to take its slope on the south side for a length of 368 ft. of the easterly end of the approach, while requiring that the north slope be retained. The maximum difference in elevation of the tracks on the approach and north of it being for this length only 10 ft., the gravity wall was used.

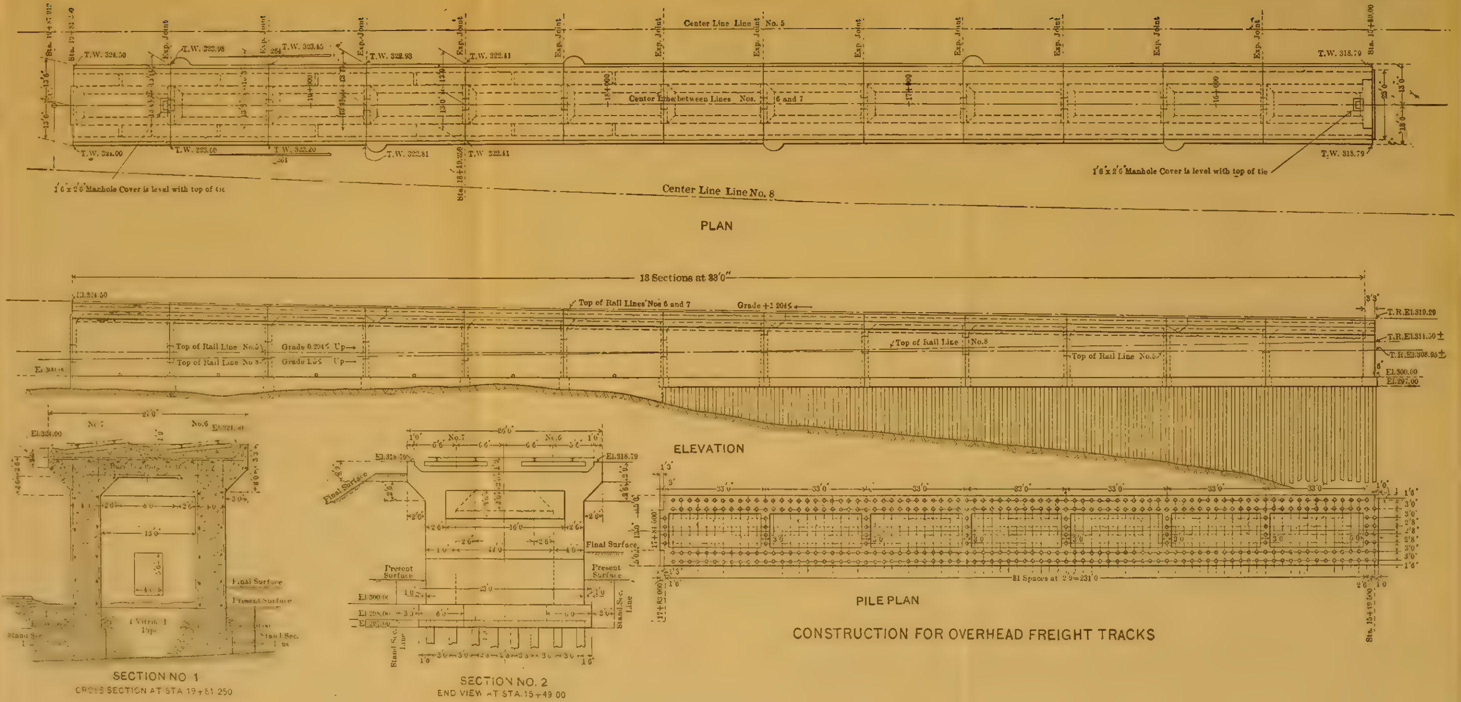
Of the easterly end of the gravity wall, which retained only from 5 to 7 ft. of embankment, a length of 142 ft. was founded on the old roadbed of the Long Island Railroad, while the remaining 226 ft. was founded on pile bents, spaced 4 ft. from center to center, and containing three and four piles in the alternate bents. Between each pair of vertical bents two batter piles were set at an angle of 20° from the vertical.

As stated above, the maximum difference in elevation of the two rails, which represents the height of material retained, was only 10 ft., and, in order to keep the piles below the ground-water level, the cut-off was 11 ft. below the low rail, which placed the major portion of the retaining wall below the surface, and seemed like unnecessarily expensive construction, but sufficient movement occurred in the low wall, founded on the old roadbed, to justify the additional expenditure on the higher wall.

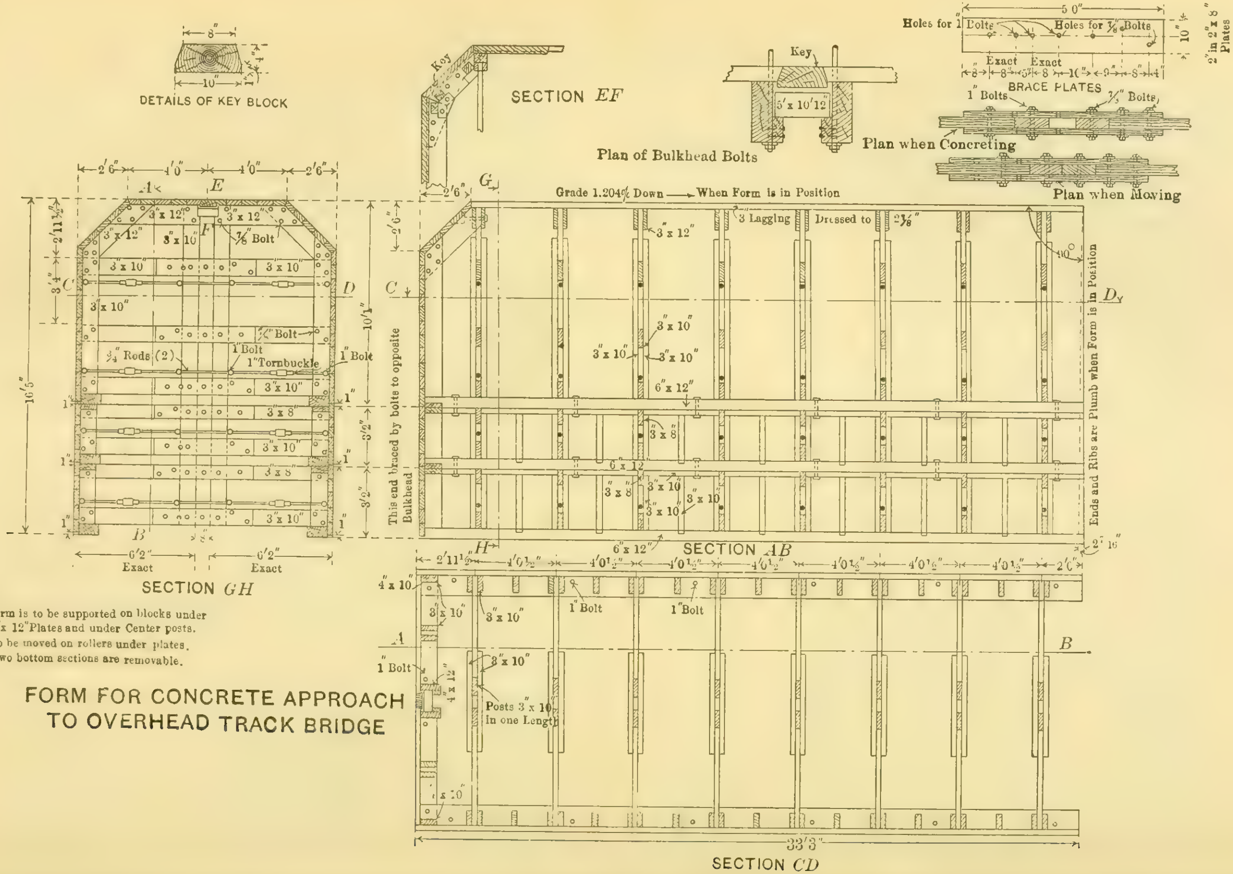
From the westerly end of the gravity wall to the abutment, a distance of 528 ft., the cellular design shown on Plate CXL was adopted. This is an unusual design, but has the advantage of being not only more stable than two retaining walls on piles, but less expensive, while, as compared with small piers and steel girders, it will probably prove more economical in the end, and has the advantage of presenting a continuous surface to any cars which may be derailed from the shifting tracks immediately adjoining it on the north and south.

The work was built in sections 33 ft. long, that being the distance between the cross-walls or bulkheads, and each section was constructed in two lifts, the first being both side-walls and bulkhead from the top of the piles or rock to a line about 1 ft. below the finished grade of the adjoining tracks, and the second, side-walls and bulkhead above that point, and roof. The construction was carried on from the west toward the east, the height of the structure diminishing in that direction and thus permitting sections of the form to be removed as the work advanced. Each bulkhead, of course, was built in conjunction with the section east of it, the rear forms for the bulkheads being the only ones that had to be knocked apart and rebuilt as the work advanced, and the timber forming them was passed ahead through the 4 by 5½-ft. openings shown on Section No. 1, Plate CXL. The interior movable form is shown by Fig. 8. It was slacked off by removing the key and tightening the turnbuckles, and, at the same time, removing wedges from under the base, the two sections, of 3 ft. 2 in. each at the bottom, being those removed as the height of the structure diminished. A view of this form and likewise the outside form is shown by Fig. 2, Plate CXXXIII. The outside form was built in two sections and picked up and swung ahead by the derricks which handled the excavation and concrete. The braces used for the outside form are shown by Fig. 1, Plate CXLI, and, in addition to those braces, the outside and inside forms were bolted together by three lines of ¾-in. bolts spaced at 4-ft. centers. Fig. 1, Plate CXLI, shows the northerly side of the abutment, which was built to conform to the cellular approach, and Fig. 2, Plate CXLI, shows the cellular work from the south side; the east end of the first pier for the steel superstructure is also shown in the foreground.

PLATE CXL.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.



CONSTRUCTION FOR OVERHEAD FREIGHT TRACKS



Note:

Form is to be supported on blocks under 6"x 12" Plates and under Center posts.
To be moved on rollers under plates.
Two bottom sections are removable.

FORM FOR CONCRETE APPROACH TO OVERHEAD TRACK BRIDGE

FIG. 8

PLANT AND OPERATION.

The contractors' plant can be classified under seven headings:

Dock Plant,
Stone-Crushing Plant,
Transportation Plant,
Mud-Disposal Plant,
Pile-Driving Plant,
Concrete-Mixing Plant,
Excavating and Constructing Plant.

The power used was steam furnished by seventeen boilers located at different points on the work, as will be hereafter described, the units varying from 20 to 125 h.p.

Dock Plant.—The dock plant was at the foot of Hunter's Point Avenue, on Dutch Kills Creek, on a dock built by the contractors on ground leased from the Long Island Railroad and private parties, the contractors having, under a permit from the City, laid tracks on Hunter's Point Avenue, then closed to traffic, from the dock to the site of the construction, a distance of 1 700 ft. Parts of the dock are shown by Figs. 1 and 2, Plate CXLII. This plant consisted of three stiff-leg derricks, two operated by Lidgerwood, 7 by 10-in. and 8¼ by 10-in., double-drum engines with 20-h.p. boilers mounted on the same frame, and Mead-Morrison, 4½ by 6-in., swinging engines, used for handling cement, brick, piles, timber, and other heavy materials delivered to the work by boat. The third, shown by Fig. 1, Plate CXLII, was operated by similar Mundy, 8 by 12-in. engines, but by steam from a separate 80-h.p. boiler, which also furnished power for a carpenter and machine shop. This derrick handled sand and stone from scows directly to cars, and, during intervals, when no cars were present, to the bins, from which the supply was drawn when no scows were on hand.

The cement was likewise usually delivered from canal-boats directly to cars, but an emergency supply was at all times kept in a warehouse at the dock having a capacity of 750 bbl.

The carpenter and machine shop, shown just back of the cement shed in Fig. 2, Plate CXLII, contained two 36-in. circular saws (one rip and one cut-off), one drill-press, one bolt machine, one pipe-cutting and threading machine, and the usual hand tools.

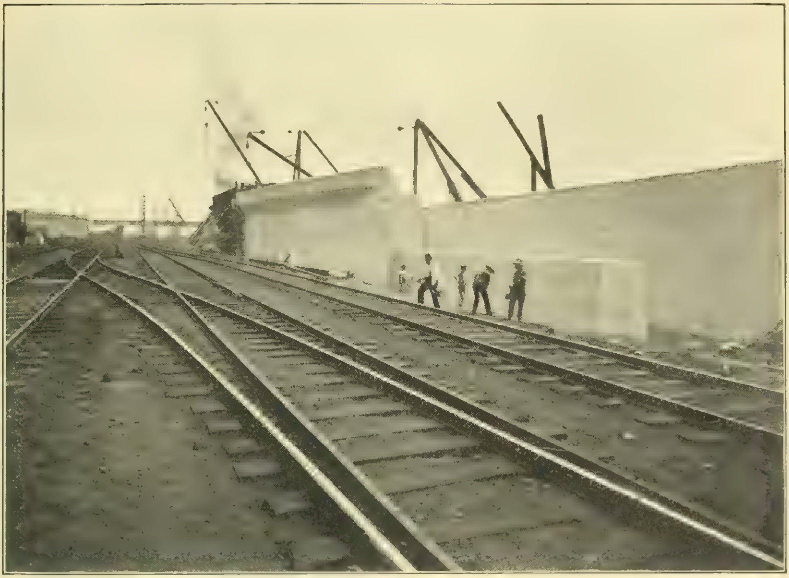


FIG. 1.—ABUTMENT FOR OVERHEAD FREIGHT TRACKS.

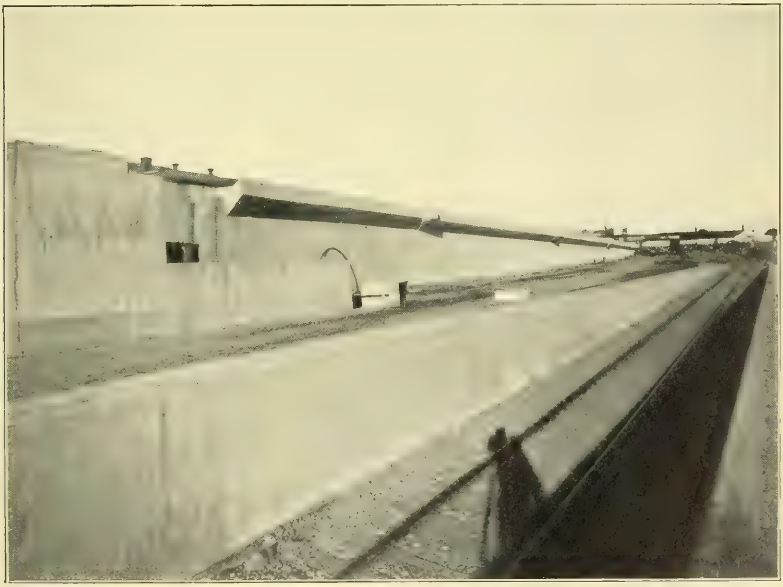


FIG. 2.—CONCRETE APPROACH TO OVERHEAD TRACK BRIDGE.

The circular saws were used largely for making ties and rough form timber from pile butts and rejects, but also to some extent in framing the heavier forms.

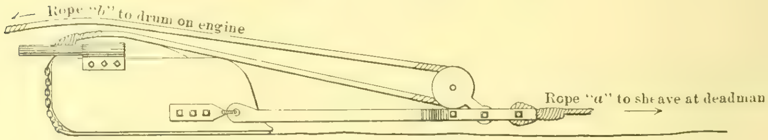
Stone-Crushing Plant.—The stone-crushing plant was near East Avenue on the southerly side of the rock excavation for the tunnels, in which position much of the rock could be handled to it directly by the excavating derricks and the remainder by a very short haul in dump-cars. The plant consisted of two (No. 5 and No. 7½) McCully crushers, erected so that the tops of the charging hoppers were only 4 ft. above the general surface of the ground, and a belt and bucket conveyor for carrying the crushed stone to screens set above bins for stone and dust which were elevated sufficiently to empty into cars by gravity. The power was furnished by a battery of three boilers, two of 125 h.p. each and the third of 100 h.p., which battery furnished steam also for drilling and for operating part of the derricks used in excavating rock and placing concrete on the adjacent work.

Transportation Plant.—The transportation plant consisted of four 10 by 16-in. American, two 10 by 16-in. Davenport, and two 9 by 14-in. Davenport locomotives, fifty-eight 4-yd. and six 3-yd. "Western" dump-cars, and sixteen 5-ton flat cars, all of 3-ft. gauge.

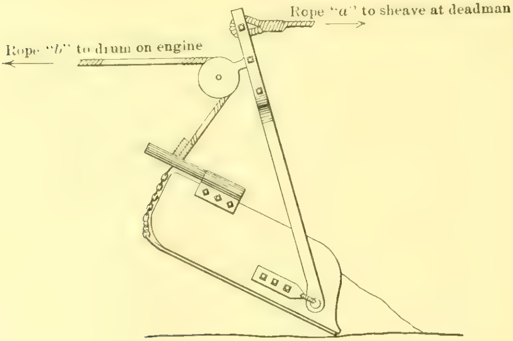
Mud-Disposal Plant.—The mud-disposal plant was made necessary by the impossibility of maintaining tracks on the swamp land south of Meadow Street, where the excavated material unsuitable for embankment was wasted. It consisted of two scrapers, specially rigged so as to be operated and dumped by double-drum, hoisting engines mounted on travelers which moved backward and forward on the edge of the swamp. The rigging of the scraper is shown by Fig. 9, the scraper being pulled forward by the rope, *A*, which passed through a sheave attached to a deadman on the opposite side of the swamp from the traveler, while the rope, *b*, was allowed to run loose, as shown in the upper part of Fig. 9, until it was desired to dump the scraper, which was accomplished by clamping the lower drum-operating rope, *A*, and pulling on the rope, *b*, until the scraper was in the position shown in the lower part of Fig. 9, when a slight pull on the rope, *A*, with the rope, *b*, slacked a corresponding amount, completed the turn. The scraper was then pulled back to the starting point by the rope, *b*.

Pile-Driving Plant.—Most of the pile-driving was done by three No. 2 Warrington steam hammers, with 3-ft. stroke and moving parts weighing 3 000 lb., mounted in 45- to 48-ft. leads of the usual type, and raised and lowered by 8¼ by 10-in., double-drum, hoisting engines mounted on the platforms of the drivers. These engines also moved the piles from the side of the excavation, at which point they were delivered by train, to the leads, and moved the drivers about by lines passed through snatch blocks and to the nigger-heads. Some piles which could not well be reached by the steam machines were driven by 2 000-lb. drop-hammers in 22- to 25-ft. swinging leads, supported by the derricks and raised by the derrick engines.

MUD SCRAPER



First Position



Second Position

Fig. 9.

The pile-driving force for one driver consisted of one foreman, one runner, from four to six dock builders on the driver, and from six to eight laborers sharpening, peeling, and handling piles.

Concrete-Mixing Plant.—There were three concrete-mixing plants in use on the work at different times, but, as they varied only in the method of charging, a description of the last erected will answer. It was located just south of Tunnels *B* and *D*, near their portals, and is shown by Fig. 1, Plate CXLIII, with the charging car in the act of dumping.

PLATE CXLII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.

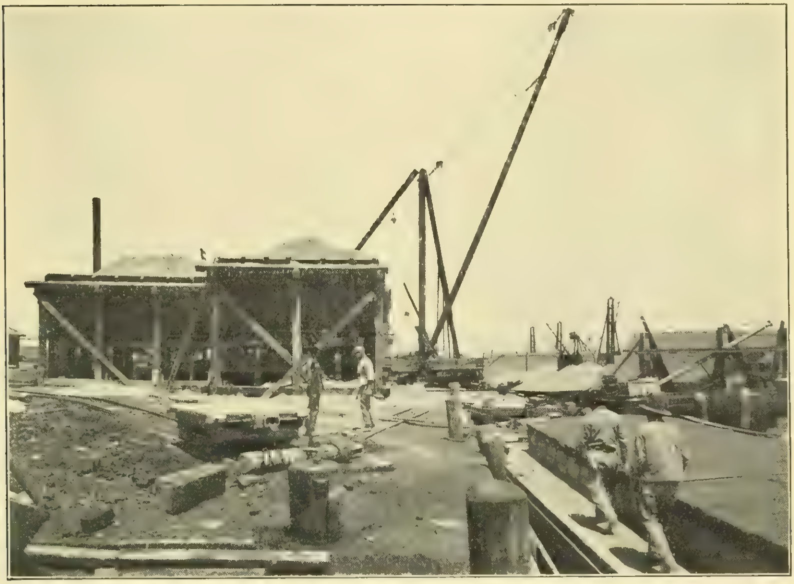


Fig. 1. View of Dock Plant.

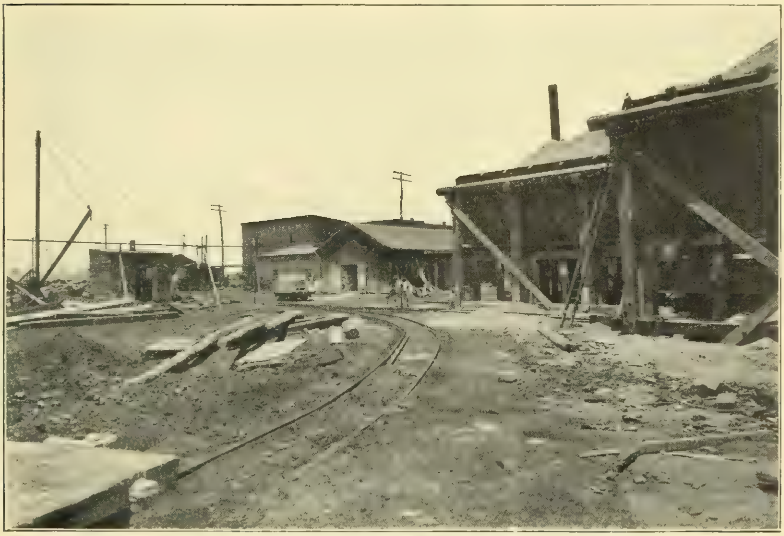


Fig. 2.—View of Dock Plant.

Fig. 2, Plate CXLIII, shows the sand- and stone-bins, and the cement-house over the charging track, with the supply tracks supported on the timber structure forming the bins, the one in the foreground leading from the crusher and the one curving to the right and crossing the temporary tracks of the Long Island Railroad overhead, to the dock previously described. The framing of the bins and the arrangements for loading the charging cars are shown on Plate CXLIV. The arrangement of the mixer and the charging cars are shown on Fig. 10.

It will be noted that the charging car had two doors, both of which were closed by gravity when the car was in a horizontal position, the front door being held shut by a latch on either side of the car. The second door, which divided the car into two compartments, the forward one for sand and the rear one for stone, was prevented from swinging back of its normal position by two bolts running through the bottom of the car. In charging, the sand compartment was first filled, thus preventing the intermediate door from swinging forward when the stone charge was received. The two compartments of the car were graduated, and the upper limits of the charge of sand and stone were marked by angle irons riveted to the sides; the quantity of cement was determined by counting the bags. The rear axle carried two sets of wheels, the first being the running wheels, of the same gauge and tread as the forward pair, and the second, having a small tread and a 5-ft. gauge, dumped the car by engaging a pair of rails at the head of the incline which continued to elevate the rear of the car while the front traveled on the level. The latch being tripped automatically when the rear of the car was raised, both doors opened by gravity and discharged into the hopper of the mixer. The water was measured in a cylindrical iron tank on the upper platform of the mixer, the quantity being regulated to suit the conditions of the sand and stone. Inlet and outlet valves, operated by the mixer runner, controlled the quantity, which was determined by an indicator attached to a float in the tank. The concrete was mixed in a 5-ft. cubical mixer, made by Thomas Carlin and Sons Company. It was belt-driven by a 10 by 10-in. Metropolitan, horizontal engine located on the ground under the incline, and discharged directly into 2-yd. Stuebner buckets standing on flat cars. The mixture was of 1, 2½, and 5 parts, by volume, and each charge contained 10 bags of cement; when deposited in the work this made 1.84 cu. yd. of concrete.

The force required to charge and operate the mixer was as follows: one foreman, one runner, one signalman, two sand and stone chargers, and four top men who handled cement and dumped cars, etc., etc. The largest amount of concrete turned out during any single shift, which in this case was of 11 hours duration, was 257 batches, equal to 473 cu. yd. measured in place.

Excavating and Constructing Plant.—The excavating plant, all of which, with the exception of the steam shovels and drills, was likewise used in building and moving forms and in placing concrete, consisted of one Thew, automatic, steam shovel, one Bucyrus, 70-ton shovel, but little used, one guy derrick with 80-ft. boom and 82-ft. mast, and twelve stiff-leg derricks having masts varying from 38 to 47 ft. and booms from 65 to 80 ft. Nine of the derricks, used in excavating swamp mud and other soft materials, were operated by 9 by 10-in. Mead-Morrison, or 8 by 12-in. Mundy, three-drum engines, and equipped with 1-yd., orange-peel buckets, the others were driven by 8¼ by 10-in., double-drum, Lidgerwood engines, with the usual 1-yd. and 2-yd. dump-buckets. All derricks had in addition 4½ by 6-in. Mead-Morrison, boom-swinging engines.

There were two travelers, each carrying two of the derricks noted above, together with their engines, and one 50-h.p., return-tubular boiler (shown in Fig. 1, Plate CXXXIII). The derricks were the shortest of those described, having 38-ft. masts and 65-ft. booms, and the engines were of the three-drum type required to operate the orange-peel buckets.

The travelers were 40 ft. from gauge to gauge, and were supported on 14 wheels, 7 to a side, of which 2 were directly under the foot-blocks of the derrick. When working, they were supported free of the rails by blocking between the outer sills of the travelers and the track ties.

SUPERSTRUCTURE FOR HUNTER'S POINT AVENUE VIADUCT.

Hunter's Point Avenue Viaduct is a steel-girder-and-column structure with a reinforced concrete floor having a 42-ft. roadway and two 10-ft. sidewalks. It is 328.5 ft. long, from face to face of back-walls, and the ends are skewed at an angle of 37°, the steel bents being on approximately the same angle. The steelwork was furnished by the Pennsylvania Steel Company, and the concrete floor was built by the Snare and Triest Company, which, as sub-contractor for the Pennsylvania Steel Company, also erected the steel.

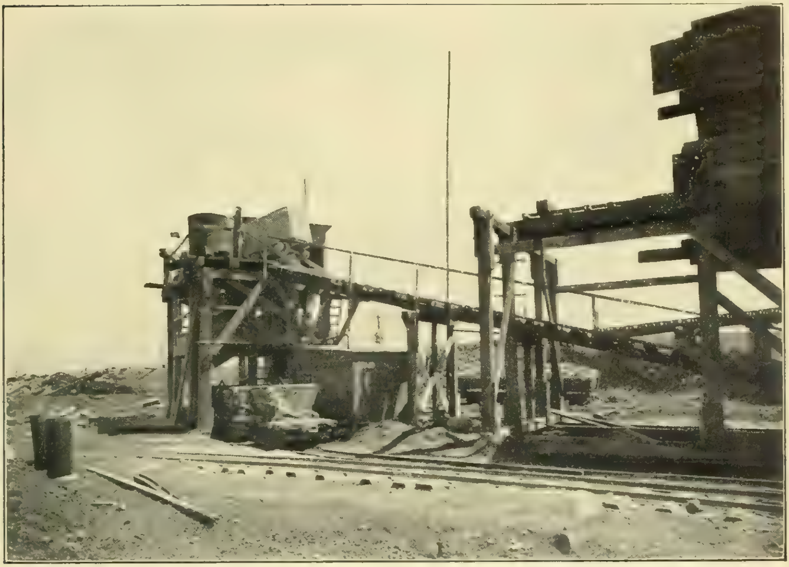


FIG. 1.—VIEW OF CONCRETE MIXING PLANT.

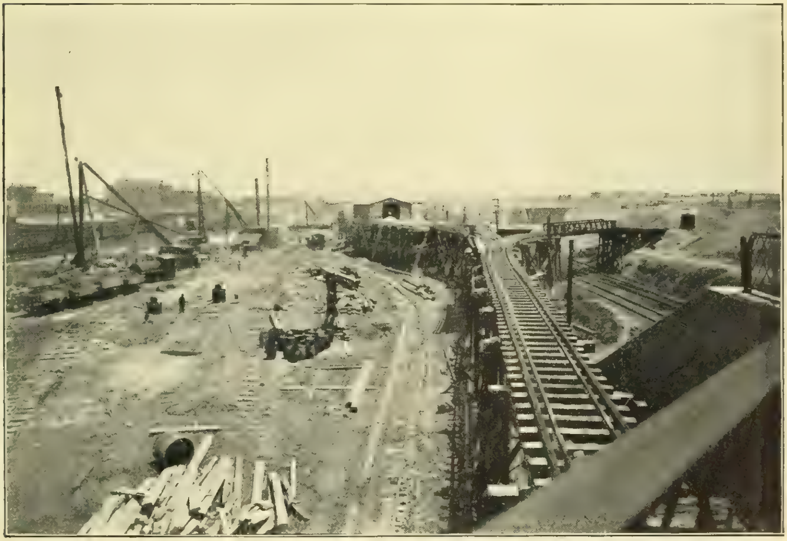


FIG. 2.—VIEW OF CONCRETE MATERIAL BINS AND TRACKS.

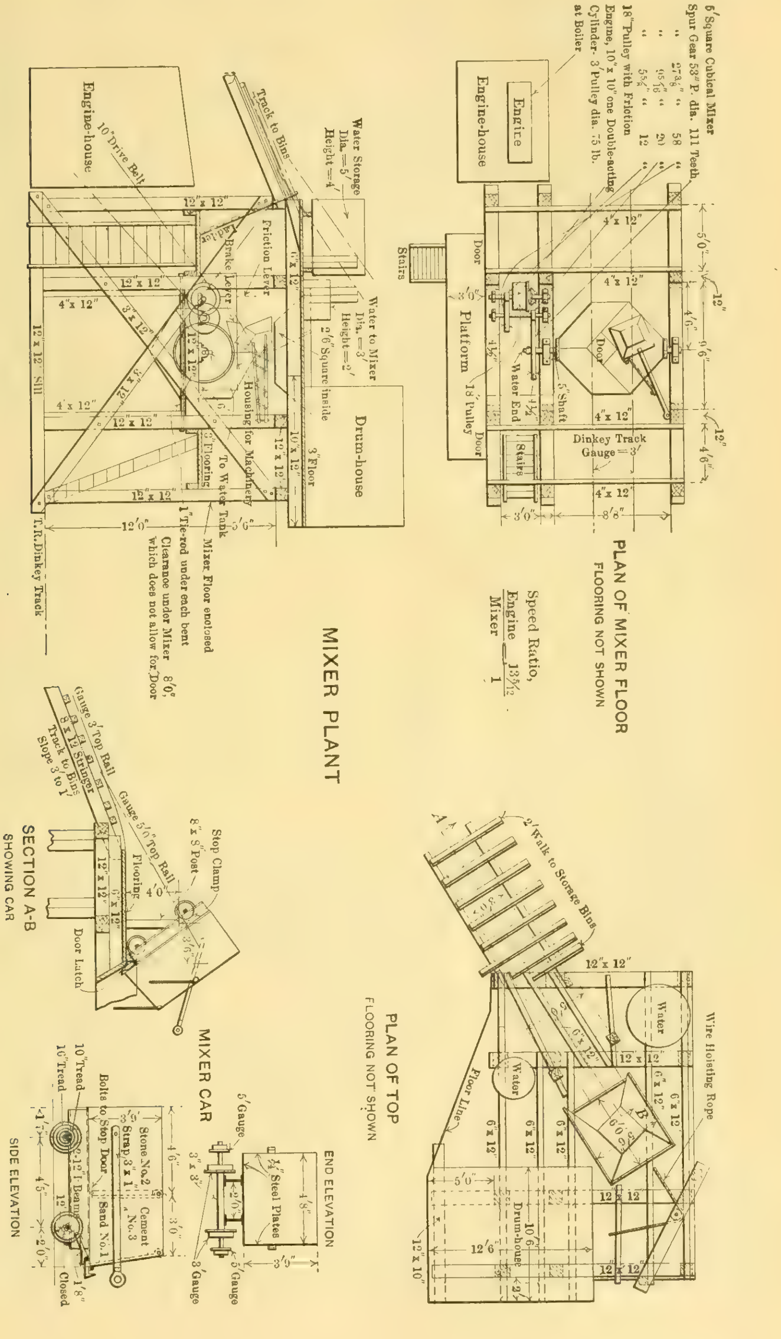

MIXER PLANT
PLAN OF MIXER FLOOR
FLOORING NOT SHOWN
6′ Square Cubical Mixer
Spur Gear 53″ P. dia. 111 Teeth
" 27⅜" " 58 "
" 9 5/16" " 20 "
" 5⅝" " 12 "
18″ Pulley with Friction
Engine, 10″ x 10″ one Double-acting
Cylinder- 3′ Pulley dia. 75 lb.
at Boiler
Engine
Engine-house
Stairs
Door
3′0″
Platform
18″ Pulley
Water End
5″ Shaft
Door
Dinkey Track
Gauge = 3′
4″ x 12″
5′0″
12″
4′6″
9′6″
8′8″
Speed Ratio,
Engine/Mixer = 13 5/12 / 1
Water Storage
Dia. = 5′
Height = 4′
Track to Bins
10″ Drive Belt
Ladder
Friction Lever
Brake Lever
Water to Mixer
Dia. = 3′
Height = 2′
2′6″ Square inside
Housing for Machinery
Drum-house
3″ Floor
3″ Flooring
To Water Tank
12″ x 12″ Sill
3″ x 12″
6″ x 12″
10″ x 12″
12′0″
5′6″
T. R. Dinkey Track
Mixer Floor enclosed
1″ Tie-rod under each bent
Clearance under Mixer 8′0″,
which does not allow for Door
PLAN OF TOP
FLOORING NOT SHOWN
2′ Walk to Storage Bins
Wire Hoisting Rope
Water
Floor Line
Drum-house
A
B
12″ x 10″
12′6″
10′6″
6′0″
SECTION A-B
SHOWING CAR
Gauge 3′ Top Rail
8″ x 12″ Stringer
Track to Bins
Slope 3 to 1
Gauge 5′0″ Top Rail
Stop Clamp
8″ x 8″ Post
Flooring
4′0″
3′6″
Door Latch
MIXER CAR
END ELEVATION
5′ Gauge
3″ x 3″
¼″ Steel Plates
3′ Gauge
4′8″
3′9″
2′0″
SIDE ELEVATION
Stone No. 2
Strap 3″ x 1″
Cement No. 3
Sand No. 1
Bolts to Stop Door
12″ I-Beam
10″ Tread
16″ Tread
4′6″
3′0″
4′5″
1′1″
2′0″
1′8″
Closed

FIG. 10.

The design and construction are so similar to that of the longer viaduct at Thomson Avenue, described in some detail in the paper by Mr. L. H. Barker, that only one feature, a rather unusual one in plate-girder construction, will be mentioned. In the northerly span, No. 1, only 3 ft. was available for depth of girder, and in Span No. 3 only 4 ft. 2 in., while Span No. 2, being over the approach to Tunnel *C*, permitted a much deeper girder. Advantage was taken of this condition by cantilevering the girders of Span No. 2 20 ft. beyond the center line of the first column bent and 15½ ft. beyond the second column bent, thus reducing the spans of the first and third girders to 43 ft. and 58 ft. 9 in., respectively, as shown in Fig. 1, Plate CXLV.

SUPERSTRUCTURE OF OVERHEAD FREIGHT BRIDGES.

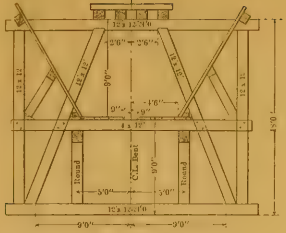
The steel superstructure of the overhead bridges for Tracks 6, 7, and 13 was designed to carry the live loads defined in the Standard Specifications for Steel Railroad Bridges issued by the Pennsylvania Railroad Company. This consists of two consolidation engines followed by a uniformly-distributed train load of 5 000 lb. per lin. ft. of track.

The double-track deck structure carrying Lines 6 and 7 is on a 9° curve. The tracks are 14 ft. from center to center, and the reinforced concrete floor, being 32 ft. wide, serves, not only as a support for the ballast and tracks, but also as a protection to trains passing underneath.

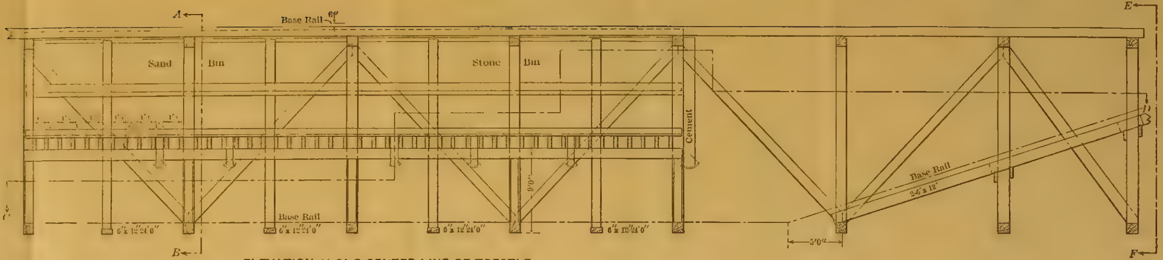
The area under the bridge is practically covered by the invert approaches to the tunnels and by surface tracks parallel to them, which necessitated constructing all supports for the bridge likewise parallel and therefore on varying and, toward the northerly end of the bridge, on very acute angles with the center line. Bracing was prevented, as the head-room was limited.

The bridge is composed of thirteen spans, and is divided into nine practically independent structures by expansion joints. The making of each structure stable on lines perpendicular to the supporting piers required rather unusual treatment. The first three sections are composed of simple beams resting at one end on the abutment and at the other supported by a pier of full height, which, on account of the acute angle mentioned above, was 234 ft. in length. This pier also carried one end of and gave lateral support to sections four and five. The

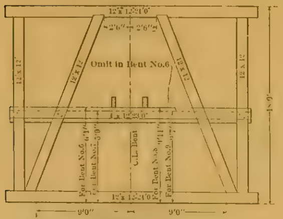
PLATE CXLIV.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.



SECTION *AB*

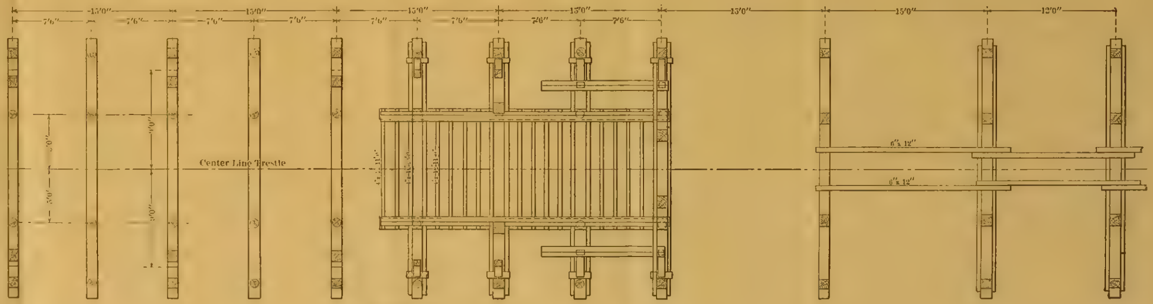


ELEVATION ALONG CENTER LINE OF TRESTLE



SECTION *EF*
BENTS-Nos 6, 7, AND 8

PLAN FOR
STORAGE BINS FOR CONCRETE MIXING PLANT



SECTION *CD*

southerly end of the bridge is likewise supported on and anchored to a pier of full height, which gives ample stiffness to the ninth section. The intermediate four sections are supported on steel columns, but stiffness is obtained by double bents, 6 and 8 ft. apart, respectively, at two points, where the spacing of the tracks permits, which, being securely interbraced, form towers, as shown by Fig. 2, Plate CXLV.

In Spans Nos. 1 and 2 the steelwork is entirely embedded in concrete, as they cover tracks which will be operated by steam locomotives, while the remainder of the steel, being over electrically-operated tracks, is unprotected, the concrete floor being nearly a slab.

In proportioning the material for the reinforced concrete floor, the extreme stress on concrete in compression was calculated not to exceed 500 lb. per sq. in., the shearing stress in concrete, 50 lb. per sq. in., and the tensile stress in the steel, 16 000 lb. per sq. in.

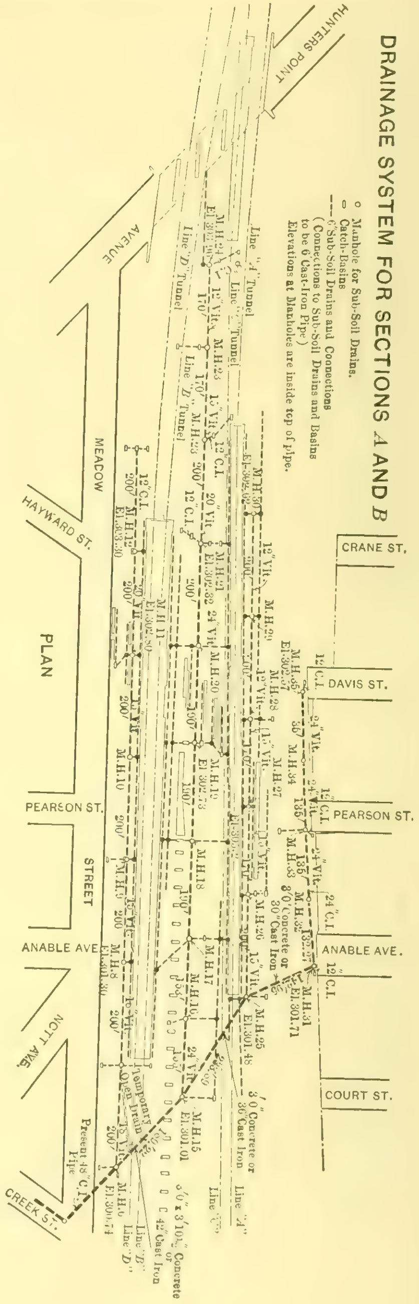
The steelwork was furnished and erected by the McClintic-Marshall Construction Company, and the concrete floor and protection by the Wilson and English Construction Company.

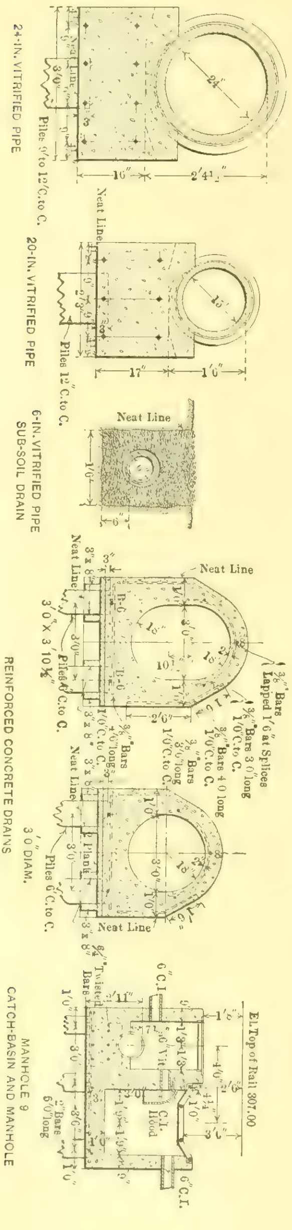
Drainage System.

The finished surface between Hunter's Point and Thomson Avenues is much in the form of a dish, the grade dropping from both avenues toward the center, and both Meadow Street and the ground north of the yard being above the level of the tracks, the lowest of which, in the vicinity of Davis and Pierson Streets, are but 5.2 ft. above mean high tide, with the sub-grade 2 ft. lower.

The city sewers in the vicinity are small and few, and too high to care for any of this area, making a private system necessary. The most available outlet was the turning basin built at the head of Dutch Kills Creek by the Degnon Realty and Terminal Improvement Company, and, as the only approach to that basin was over the property of the Realty Company, arrangements were made with them to construct a 4-ft. cast-iron outlet sewer from the Railroad Companies' property on the northerly side of Meadow Street to the basin. The remainder of the system was constructed, under a separate contract, by Naughton Company and Arthur McMullen. The layout is shown by Fig. 11.

The top of the intrados at the outlet was located at Elevation 300, mean high tide, and on the hydraulic gradient for that stage of the





STANDARD CROSS-SECTIONS OF DRAINS

FIG. 11.

PLATE CXLV.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
CLARKE ON
PENN. R. R. TUNNELS:
APPROACHES TO EAST RIVER TUNNELS.

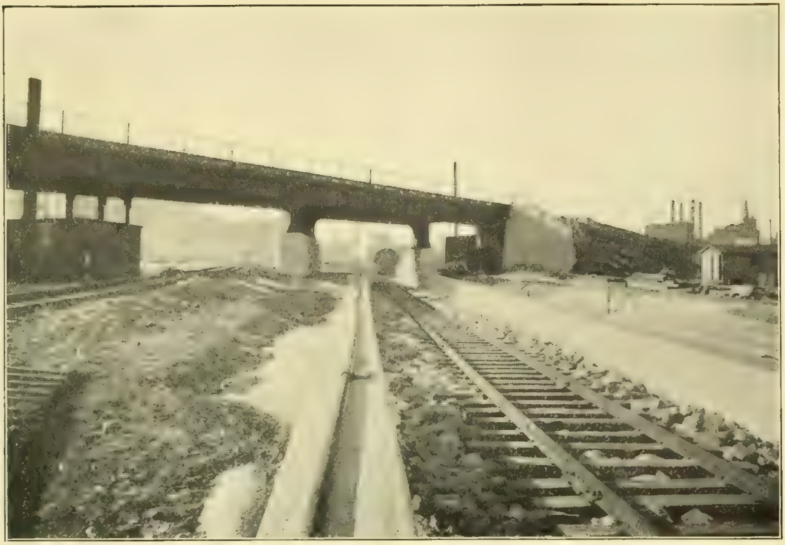


FIG. 1.—HUNTER'S POINT AVENUE BRIDGE: CANTILEVER GIRDER.

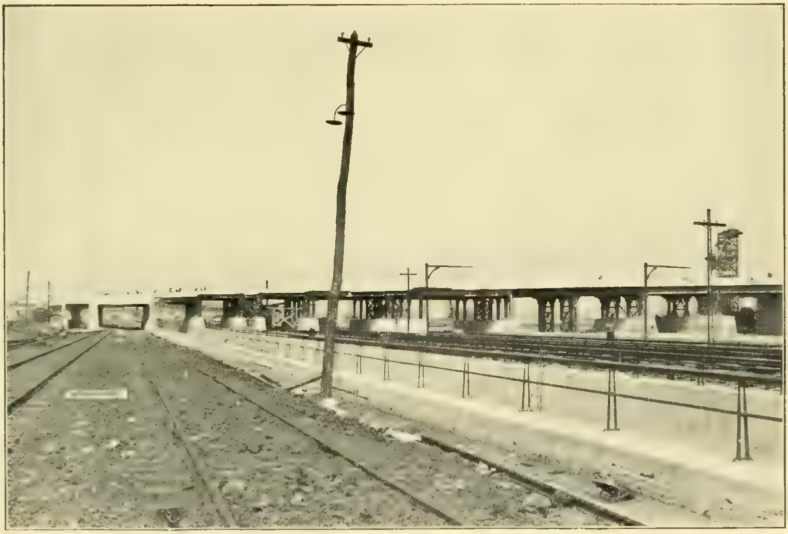


FIG. 2.—VIEW OF OVERHEAD DOUBLE TRACK.

tide throughout. The sizes were fixed for a full pipe at that stage, with a run-off of 2 in. per hour from the concrete inverts and 1 in. per hour from the remainder of the area drained. It was recognized that the latter run-off is large for a railroad yard, but as the grades were flat and the ditch room limited, it was necessary to place catch-basins at frequent intervals over most of the area. It was impossible to locate surface ditches over a considerable portion of the area, and, therefore, sub-soil drains were laid, as shown by Fig. 11, the lower half of each joint in the pipe being left open, the upper half cemented, and the stone covering carried to the surface, it being intended that the drains should act as conduits for surface-water rather than perform the usual functions of sub-soil drains. Both the sub-soil drains and ditches empty into catch-basins having their bottoms well below the outlet to the sewer.

Vol. XXXVI. AUGUST, 1910. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE NEW YORK TUNNEL EXTENSION OF THE PENNSYLVANIA RAILROAD.
THE SUNNYSIDE YARD.

By Louis H. Barker, Esq.*

To be Presented September 21st, 1910.

One of the sections of the East River Division of the New York Tunnel Extension of the Pennsylvania Railroad is called The Sunnyside Yard. It is the terminal passenger yard of that railroad in New York City, and is located in Long Island City, Borough of Queens, about 3.5 miles from the Terminal Station and 1.6 miles eastward from the East River. The name Sunnyside is derived from the local name of the neighborhood. The Sunnyside Yard Section extends from 10 ft. west of Thomson Avenue to the east side of Woodside Avenue, a distance of 8 500 ft., has a maximum width of 1 625 ft., and embraces 208 acres.

This paper gives a description of the general plan of the Yard, together with some of the special features of its design and construction.

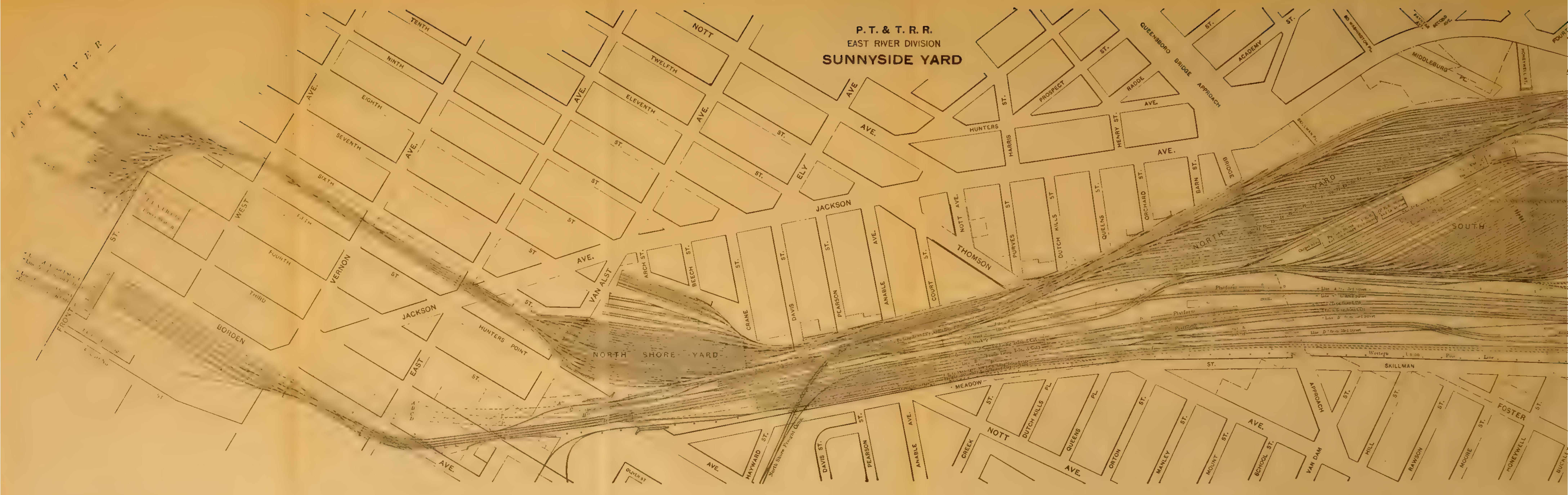
General Plan.

The general plan of The Sunnyside Yard, Plate CXLVI, was prepared by a committee appointed for that purpose. On June 15th, 1906, it was submitted to the Board of Estimate and Apportionment

---

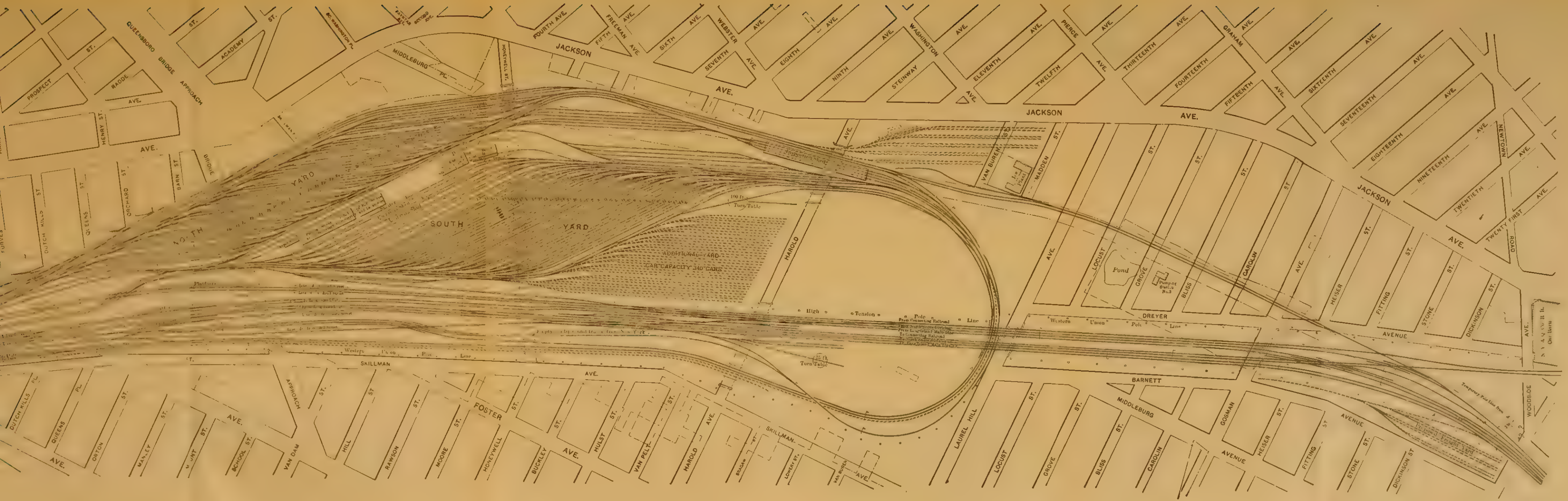
Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings,* and, when finally closed, the papers, with discussion in full, will be published in *Transactions.*

* Res. Engr., The Sunnyside Yard, Pennsylvania Tunnel and Terminal R. R. Co.



P. T. & T. R.R.
EAST RIVER DIVISION
SUNNYSIDE YARD

PLATE CXLVI.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
BARKER ON
PENNSYLVANIA R. R. TUNNELS: THE SUNNYSIDE YARD.



of the City of New York, with an application for the required change in the map of the City and the necessary permission to proceed with the work of construction. By resolution of that Board, on February 15th, 1907, the proposed changes in the City map were authorized, and after the execution of an agreement, between the City of New York, the Pennsylvania, New York, and Long Island Railroad (now called the Pennsylvania Tunnel and Terminal Railroad), and the Long Island Railroad, dated June 21st, 1907, the plan was approved by the Mayor.

This agreement, in part, called for the following: The vacation of all or parts of 52 streets, Plate CXLVII; the opening of portions of 5 streets; the changing of the grades of 15 streets; the construction of 8 highway bridges, 6 overhead (Van Alst Avenue, Hunter's Point Avenue, Thomson Avenue, Bridge Approach, Honeywell Street, and Harold Avenue), 2 undergrade (Laurel Hill Avenue, and Gosman Avenue); and 7 railroad bridges.

Sunnyside Yard, which is exclusively for passenger equipment, is divided into two separate yards, called "North Yard" and "South Yard." In the "North Yard" will be stored cars of the multiple-unit type used in connection with the suburban traffic; the "South Yard" will be used for storage, cleaning, and repairing Pullman cars, dining cars, and coaches. Between these two yards are located the necessary store, supply, and other yard buildings, together with a sub-station and boiler-house. A driveway is provided from Honeywell Street and a stairway from the Bridge Approach Viaduct leading to these buildings.

An important feature of the plan of the Yard is a loop at its east or rear end around which all empty trains will pass before entering it. This turning movement of the entire train by passing around this loop will avoid the necessity, existing at the present terminal at Jersey City, of uncoupling "observation" or other special cars, and turning one car at a time on a turn-table, which, together with the movement required through the crowded yard, makes it a very slow and expensive operation.

It is arranged that the empty trains will enter at one end and leave from the other end of the Yard, thereby avoiding conflicting movements and delay incident to any yard having the entrance and exit at the same end The shifting movements of the trains found necessary after being placed in the Yard will be made at its east end, where four simultaneous movements may take place on tail-tracks provided for that purpose. This will leave the west end of the Yard free for the more important movements of the departing trains of empty cars to the New York Passenger Station. In order to avoid delay due to conflict of movements, it is further provided that in all cases the main tracks pass over the yard tracks by bridges.

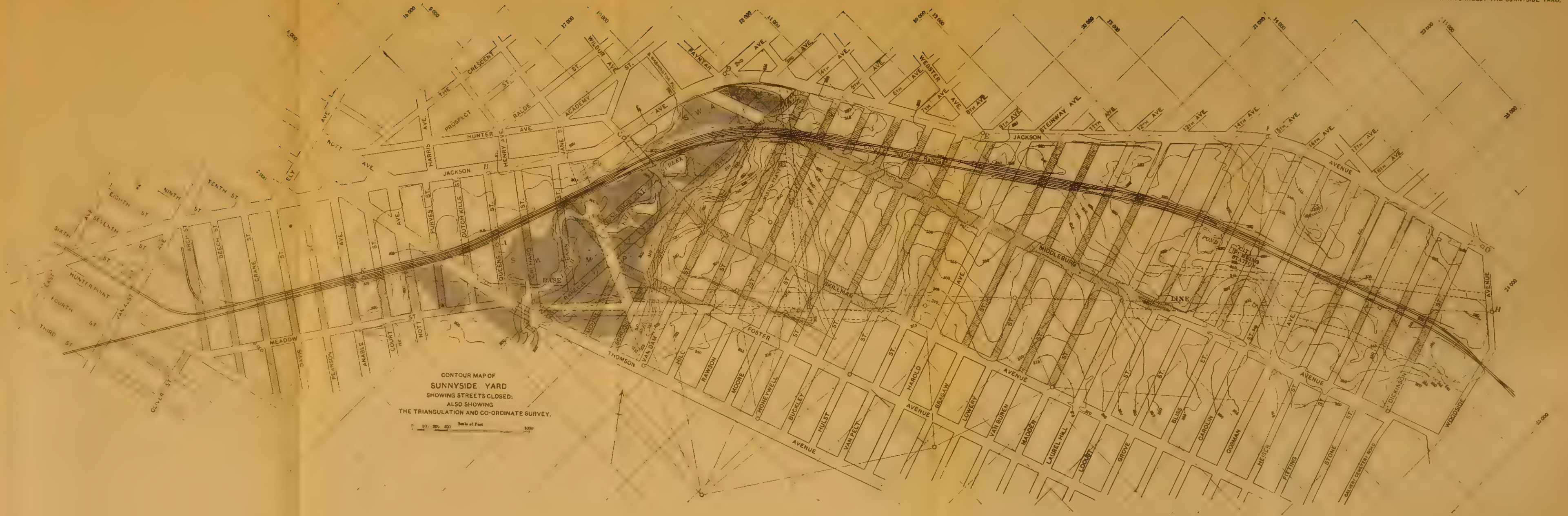
In the plans of Sunnyside Yard as well as in the work of construction throughout it, the possible future building of two additional lines, "E" and "F," leading from two tunnels under the East River connecting with 31st Street, Manhattan, has been kept in view, together with a possible future extension of the Yard near Harold Avenue as shown by dotted lines on Plate CXLVI.

The capacity of the completed Yard will be as follows:

North Yard.—42 tracks, multiple-unit cars 62 ft. long. .	526 cars.
South Yard.—45 tracks, Pullman cars and coaches 80 ft. long, with one electric locomotive 65 ft. long on each track	552 "
South Yard (dotted addition).—32 tracks, 50% 80-ft. cars and 50% 62-ft. cars.	309 "
Total.	1 387 cars.

Originally, a swamp of 40 acres extended from the present location of Honeywell Street and Jackson Avenue to Thomson Avenue, and comprised a portion of the required Yard area; the remaining 168 acres within that area was rolling ground from 10 to 70 ft. above the swamp. Upon this high ground there were 246 buildings of all kinds, and these were purchased and torn down or removed. A view of the swamp in the early stages of the work is shown by Fig. 1, Plate CXLVIII. A vegetable growth, of the nature of peat, from 1 to 4 ft. in thickness, formed the surface of the swamp, except in the bed of Dutch Kills Creek; beneath this there was a layer of mud, and in the bed of the stream a blue-black clay of the consistency of putty. As this muck and clay would move under the pressure of the filling over it, and produce waves of considerable height, it was specified in the contract that a blanket of earth about 4 ft. thick should be first placed over this part of the Yard area, in order to prevent this wave

PLATE CXLVII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
BARKER ON
PENNSYLVANIA R. R. TUNNELS: THE SUNNYSIDE YARD.



CONTOUR MAP OF
SUNNYSIDE YARD
SHOWING STREETS CLOSED:
ALSO SHOWING
THE TRIANGULATION AND CO-ORDINATE SURVEY.

formation. This proved efficacious, except in one or two places, where, owing to unusual depth of filling, the wave formation broke through this covering and rose to such a height as to require excavation of the peat, muck, and mud, in order to secure proper track foundations. In the bed of Meadow Street, where the embankment was very high, the crest of one of the mud waves rose to an elevation of 28 ft. above the swamp. This mud wave is shown in Fig. 2, Plate CXLVIII.

Plate CXLVII, shows the contours of the Yard site in December. 1906, before any work was begun, and also the location and extent of the swamp, and the location of the streets and railroad tracks at that time. The elevations on the contour and other maps and plans attached to this paper have reference to a datum elevation of 300, corresponding to the plane of reference, M. H. W. of the Rapid Transit Commission of New York City.

SURVEY OF THE YARD SITE.

A system of co-ordinates, with origin at the corner of First Avenue and 34th Street, Manhattan, had been established in connection with the East River tunnel work, and it was thought desirable that this same system be extended to embrace all the Sunnyside Yard area. To that end very accurate measurements, with standardized steel tapes, with fixed pull, and calculated allowances for temperature and inclinations of the tape, were made at night from one of the established monuments of the tunnel survey line, thence along Jackson Avenue for 11 141.273 ft. to a point on Woodside Avenue, with check measurements, using a different tape, back along the same line to the starting point. At each angle point a cemented iron-pipe monument was placed, and the angles were carefully read with a 10″ instrument, with from 5 to 10 repetitions. From the Woodside Avenue monument a working base line, 9 360.820 ft. long, was then established through the central part of the Yard. Owing to the houses obstructing the base line, and the difficulty of measuring over the swampy area and Dutch Kills Creek, points along the base line and on the south side of the Yard were determined by triangulation from the monumented line on Jackson Avenue. Using the co-ordinate system, equations were determined for the base line, bridge and street center lines, and for the principal track-tangents and curves, and proved of great value. The monumented line, base line, triangulation system, and co-ordinate system are shown on Plate CXLVII. At every 500-ft. point along the base line a large stake was placed; smaller intermediate 100-ft. stakes were set between them, and all were painted white. In order to avoid mistakes in identifying these smaller stakes, owing to the great number of stakes throughout the Yard, the corners of their square tops were cut as shown by Fig. 1, namely, one corner cut = 100 ft., two corners cut = 200 ft., etc.

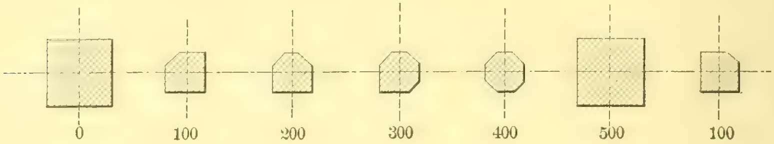


FIG. 1.

EXCAVATION.

Excavation was begun in December, 1906, and amounted to about 3 000 000 cu. yd. Notwithstanding the great amount of filling over the swamp and low ground, there was an excess of excavated material. Part of this excess was used by the Long Island Railroad in new construction work at near-by points and part by the Degnon Realty and Terminal Improvement Company in filling some of the swampy part of its property. The excavation consisted entirely of sand and gravel, with varying amounts of glacial deposit of water-worn gneiss, sandstone, and trap boulders. These boulders, while numerous and somewhat troublesome in places, formed on the whole a smaller portion of the excavation than was anticipated from surface indications. Nearly all that were suitable were broken and used in the concrete masonry. The only bed-rock exposures were in the bed of Dutch Kills Creek near the south abutment of Thomson Avenue Bridge and near Orchard Street, south of the Long Island Railroad tracks, but no rock excavation was found necessary except at the south abutment, and Piers Nos. 12 and 13 of Thomson Avenue Bridge, and for the sewer under the Long Island freight tracks on the north side of the Yard opposite Buckley Street. Under the swamp, the bed-rock was generally from 30 to 50 ft. below the surface. This depth was ascertained from wash-borings and by the length of the piles used. An abundance of clean, sharp, and reddish-colored sand was found in the general excavation throughout the Yard. This sand, when tested with cement, gave a stronger mortar than the Hempstead Harbor sand (the New York

PLATE CXLVIII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
BARKER ON
PENNSYLVANIA R. R. TUNNELS: THE SUNNYSIDE YARD.

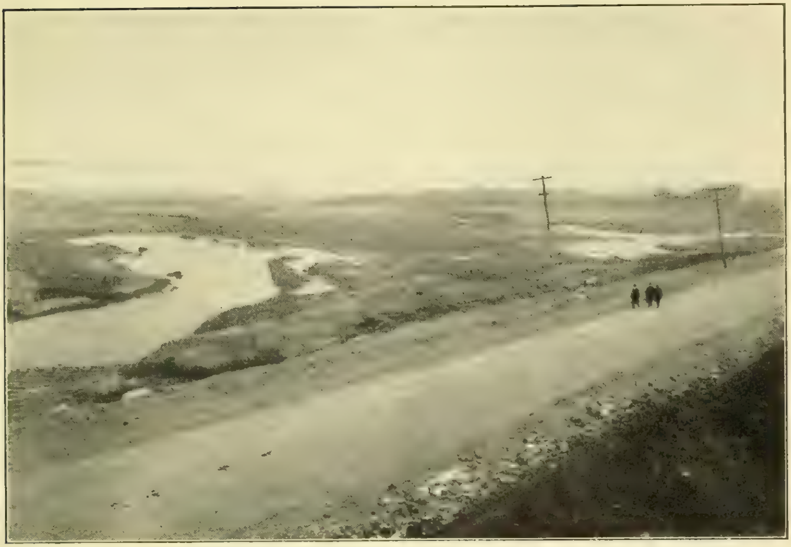


Fig. 1.—View of 40-Acre Swamp Now Forming Part of Sunnyside Yard.

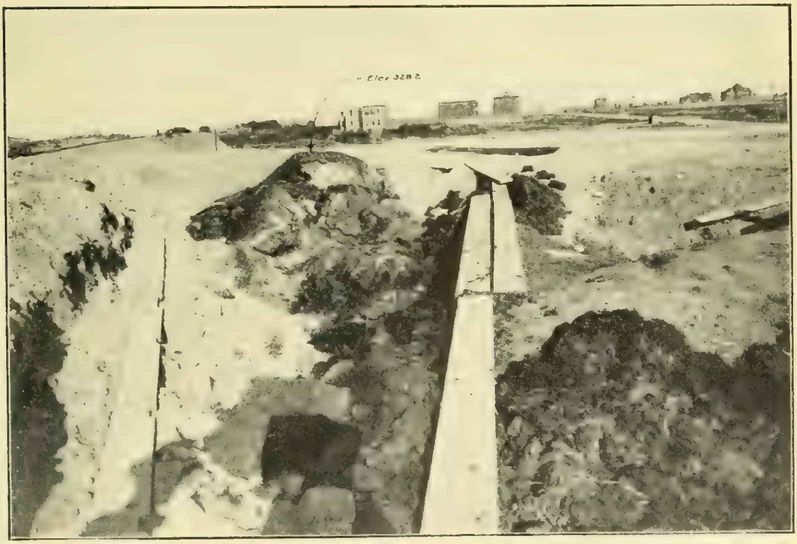


Fig. 2.—Mud Wave, 28 Ft. High, in Swamp.

PLATE CXLIX.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
BARKER ON
PENNSYLVANIA R. R. TUNNELS: THE SUNNYSIDE YARD.

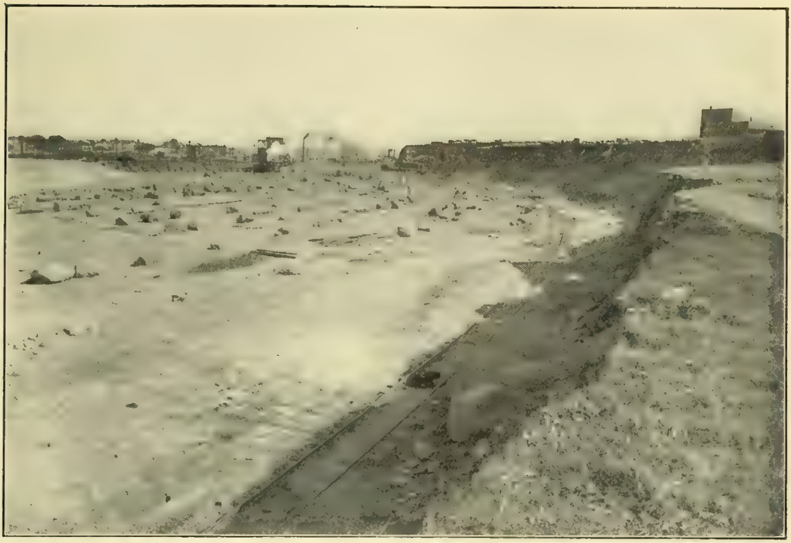


FIG. 1.—EXCAVATION FOR SOUTH YARD.

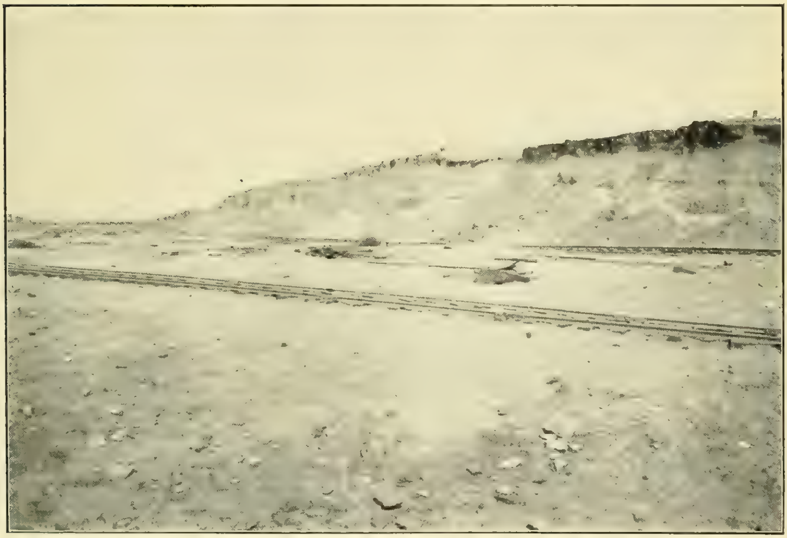


FIG. 2.—EXCAVATION FOR SOUTH YARD.

City standard sand) and, therefore, it was used in all bridge and sewer work. In constructing the sewer along the north side of the Yard between Moore and Buckley Streets, a very fine, whitish, quicksand was encountered, and gave considerable trouble. This sand was so fine that 70% would pass through a No. 200 sieve.

Figs. 1 and 2, Plate CXLIX, and Fig. 1, Plate CL, show the depth of excavation and the character of the materials in different parts of the Yard.

Water in very large quantities was encountered in almost all excavations for masonry foundations westward from Laurel Hill Avenue, and in some foundations it became necessary to pump as much as 400 gal. per min. This ground-water stood at Elevation 324 at Laurel Hill Avenue, sloping gradually to 310 in the high ground near the swamp. Over the swamp area the water elevation was about 300.

The Degnon Realty and Terminal Improvement Company, of New York City, was the contractor for the excavation, and for the bridge and sewer masonry. In the work of excavation the contractor's plant varied: At its maximum it consisted of 3 Bucyrus and 1 Thew steam shovels, 11 narrow-gauge locomotives, 150 4-yd. dump-cars, and about 10 miles of track. The maximum excavation for one shovel for one 10-hour day was 3 500 cu. yd., in April, 1908. The maximum excavation for one shovel for one month was 60 615 cu. yd., in January, 1909. Owing to the difficulty of lighting the work properly, but little shovel excavation was done after dark.

MASONRY.

All masonry is of concrete except in the buildings above the foundations and in sewer manholes, where brick was used. The concrete in the bridge piers, abutments, and retaining walls was composed of 1 part cement, 3 parts sand, and 6 parts broken stone. In sewers the proportion was 1 : 2½ : 5, and in bridge floors, 1 : 2 : 4. The size of stone used in the first case was between ⅜ and 2¼ in., in the second case between ⅜ and 1 in., and in the third between ⅜ and 1¼ in., ring measurement.

Where concrete masonry exceeded 5 ft. in thickness, the use of large stones was permitted up to 25% of the total volume of the masonry. The stones were placed at least 6 in. apart at every point and not nearer than 12 in. to the faces of the masonry.

Four Ransome concrete mixers were used in the general contract work. Three of these mixers were placed at the crusher plant near Honeywell Street. This crusher plant, Fig. 2, Plate CL, contained one No. 4 and one No. 6 Gate's crushers, together with stone- and sand-hoisting belts and the necessary storage bins. From these mixers to points within about 3 000 ft., the concrete was transported in 1-yd., square-bottom dump-buckets placed on narrow-gauge cars and hauled by narrow-gauge locomotives. For distances greater than 3 000 ft., a mixer was erected at the site of the work, as it was found that after hauling about that distance the mixture began to separate. In order to secure a uniform finish, the exposed faces of the concrete masonry, as a general rule, had a facing of mortar 2 in. thick deposited simultaneously with the concrete and separated from it by metal diaphragms which were removed immediately, and the excess mortar was spaded into the concrete. Above the foundations of the abutment and pier masonry, the concrete was laid continuously to completion. By this method, not only a perfect monolithic structure was obtained, but the formation of all unsightly joints between the different days' work was prevented. Expansion joints were placed about 50 ft. apart in all abutments and piers above the foundations.

Only reinforcing rods of the twisted, square section were placed in the floors of the bridges and buildings, but in the bridge masonry, sewers, pipe tunnels, and pipe trenches, both twisted and corrugated bars, and expanded metal were used.

Plates CLI, CLII, CLIII, and Fig. 1, Plate CLIV, show various pieces of masonry in different stages of construction.

BRIDGES.

The highway bridges crossing over the Yard are all of the deck plate-girder type. They were made to conform to the layout of the tracks in the Yard, and, therefore, required a great diversity of lengths of spans and irregularity in pier alignment. In order to secure a minimum clearance of 16½ ft. above the top of rails, it was necessary in several cases to introduce girders of shallow depth. Between the abutments the girders are supported on steel columns resting on and anchored to concrete piers. The columns are of a built **H**-section composed of four angles and two channels, and where they are adjacent to running tracks, they have concrete protection for about 6 ft. above the rails.

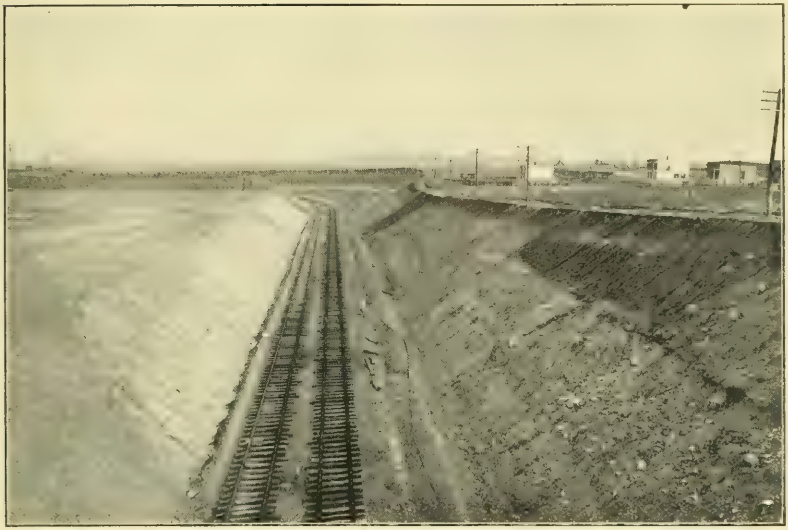


FIG. 1.—EXCAVATION FOR LOOP TRACKS.

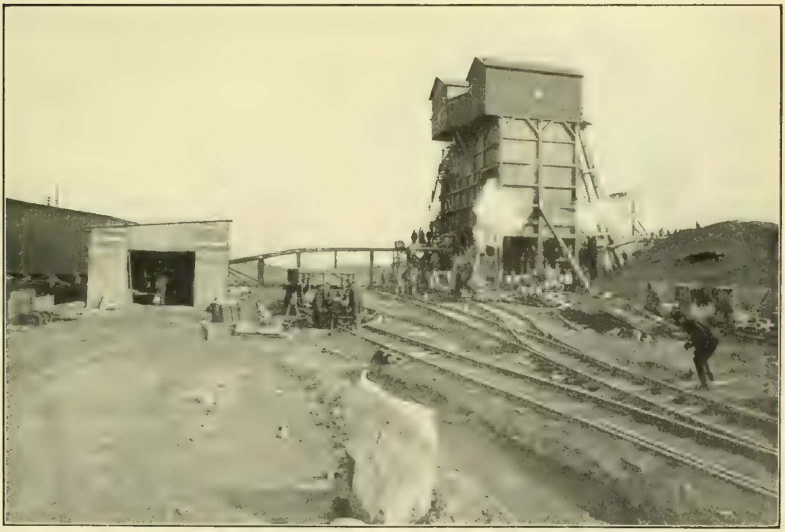


FIG. 2.—CRUSHER, AND CONCRETE MIXING PLANT.

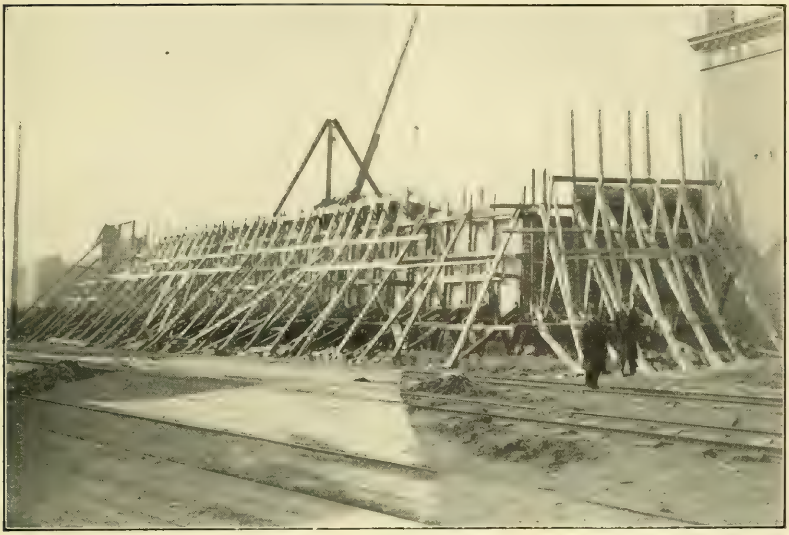


FIG. 1.—FORM WORK FOR MASONRY OF NORTH ABUTMENT, THOMSON AVE. BRIDGE.

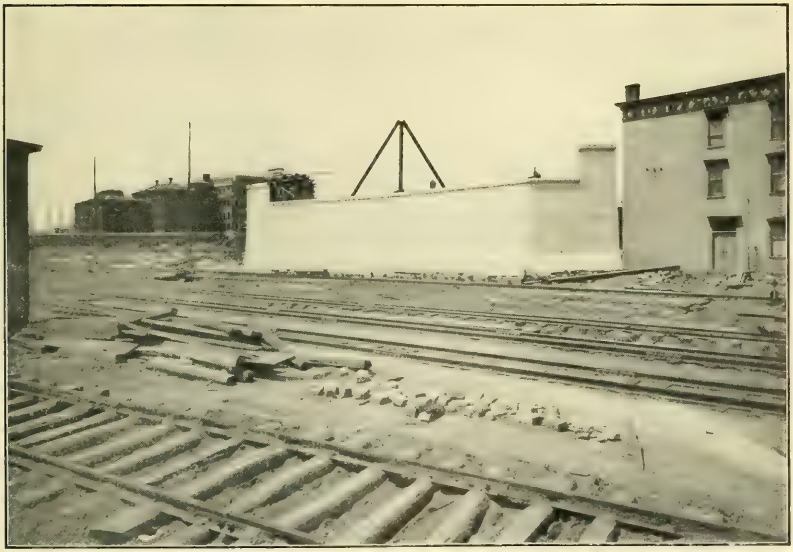
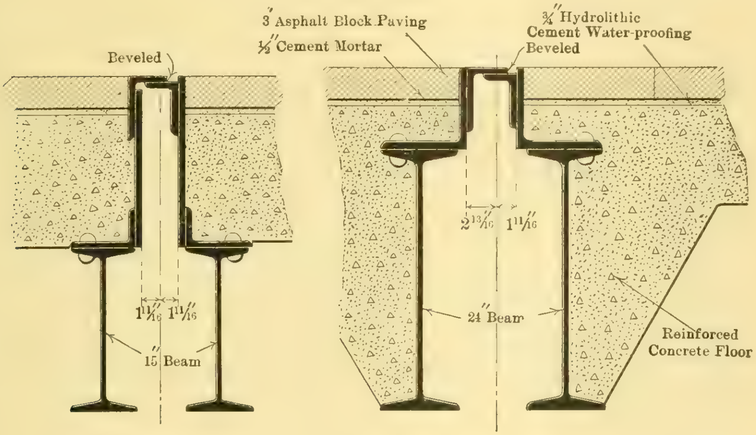


FIG. 2.—THOMSON AVE. BRIDGE: MASONRY OF NORTH ABUTMENT ABOUT COMPLETED.

The flange stress in the girders was calculated not to exceed 13 000 lb. per sq. in., no allowance being made for impact. The web plates are generally ⅜ in. thick, except where heavier metal was required to give sufficient bearing area for rivets. Expansion joints (cross-sections of which are shown by Fig. 2), are provided at intervals of about 150 ft. Provision has been made for double-track street-car lines on all bridges, but the rails are not yet laid. A typical panel of hand-railing is shown by Fig. 3.

In some cases where bridges pass over freight tracks which will be operated for a time by steam locomotives, a number of the girders are encased in concrete to prevent destructive smoke action.



SECTION IN ROADWAY

SECTION UNDER CAR TRACK

TYPICAL EXPANSION JOINTS FOR HIGHWAY BRIDGES

FIG. 2.

Reinforced concrete floors have been used in all bridges.

In proportioning the materials for the floors of highway bridges, a concentrated wheel load of 12 000 lb. was assumed to be distributed over a length of floor slab equal to one-third of the span from center to center of the girder, plus an additional length equal to the thickness of the slab.

The extreme fiber stress on concrete in compression was assumed not to exceed 500 lb. per sq. in., and the shearing stress 50 lb. per sq. in. The tensile stress allowed in the reinforcing steel rods was 16 000 lb. per sq. in.

To insure the longitudinal distribution of the load as assumed, and to guard against shrinkage cracks, longitudinal reinforcing rods were used having an aggregate net section equal to 50% of the aggregate net section of the transverse reinforcement.

Within 24 hours after the floor concrete was placed in the driveway portion of these bridges, a ¾-in. covering of Hydrolithic water-proof cement was spread over them, and a granolithic finish, 1 in. thick, was placed on the sidewalks. Asphalt paving blocks, 3 in. thick, were laid on the driveway on ½ in. of 1 : 3 cement and sand mixed with a small proportion of water.

Fig. 4 shows typical cross-sections of the highway bridges.

Thomson Avenue Bridge.—All masonry in this bridge is on piles, with the exception of the south abutment, Pier No. 13, and part of Pier No. 12, which are on rock, and a small part of the north approach wall which is on earth foundation. Batter piles were used under the north abutment and the high retaining walls of the north approach. A city water pipe, 16 in. in diameter, had been placed in Thomson Avenue prior to the inception of the Tunnel Company's work. Where it crossed the pier sites it was built into the masonry. The danger of breaking, due to the weight of the embankment to be built over it, made it necessary to replace the pipe by a new one to be carried on the bridge superstructure. At the request of the City, a 20-in. pipe was put in. As the depth of the girders in several spans was not sufficient to provide for suspending this pipe below the floor in a satisfactory manner, it was decided to let it rest on the deck of the bridge and occupy a part of the sidewalk. In order to overcome the effect due to the bridge expansion on the pipe if laid directly on the bridge, and avoid the use of expansion pipe-joints, the pipe was suspended in saddle supports, as shown by Fig. 5, which has proved a satisfactory solution of the difficulty.

Bridge Approach Viaduct.—All the masonry of this bridge is on piles, except the south abutment, which is on filled sand foundations. As a number of the girders were of insufficient depth to carry the city water pipes below the floor, a width of 3 ft. 6 in. was added on both sides of the bridge, outside of the hand-rail, for that purpose.

Honeywell Street and Harold Avenue Bridges.—The piers and abutments of these bridges are on sand and gravel foundations without piles. A 12-in. water pipe is supported on 2½ by ⅜-in. strap-hangers

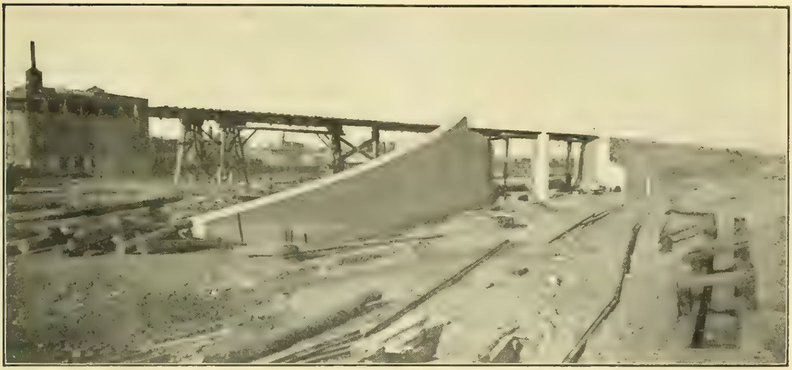


Fig. 1.—Bridge No. 5: Masonry Ready for Superstructure.

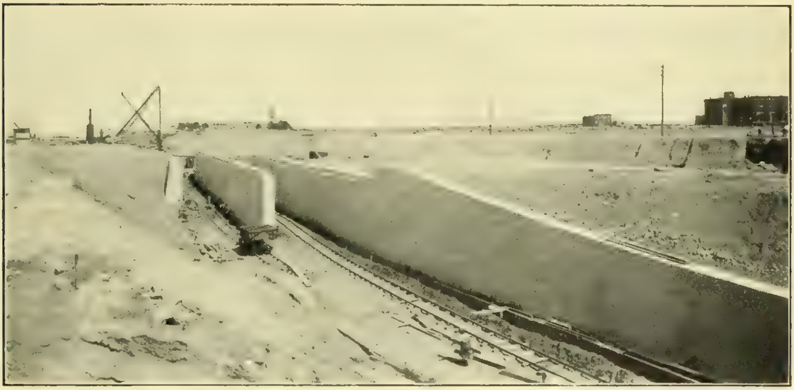


Fig. 2.—Bridge No. 4: Masonry Ready for Superstructure.

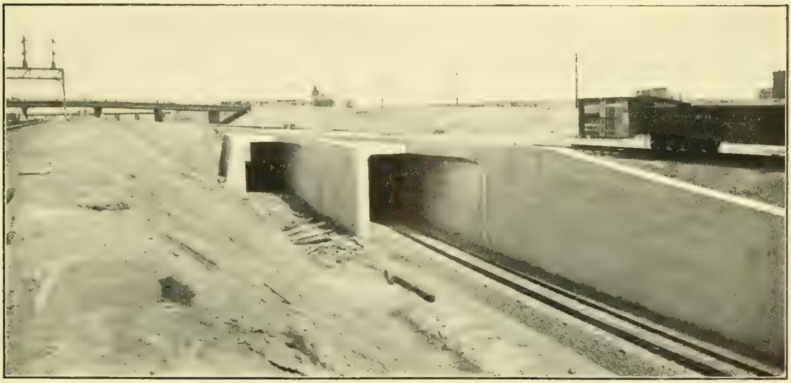
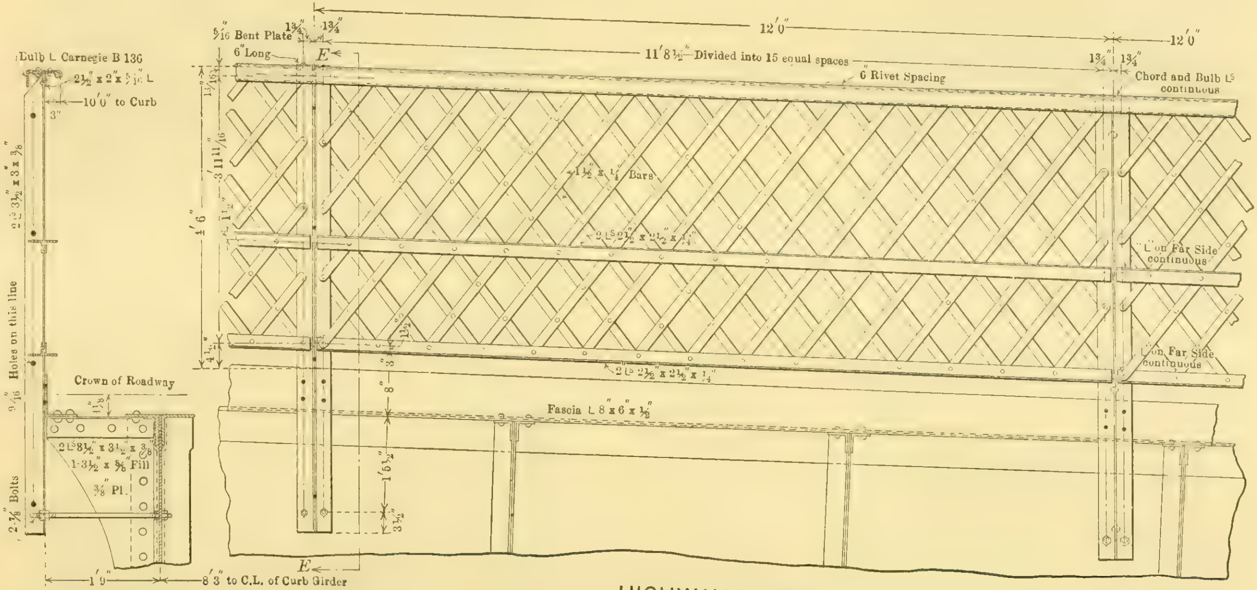
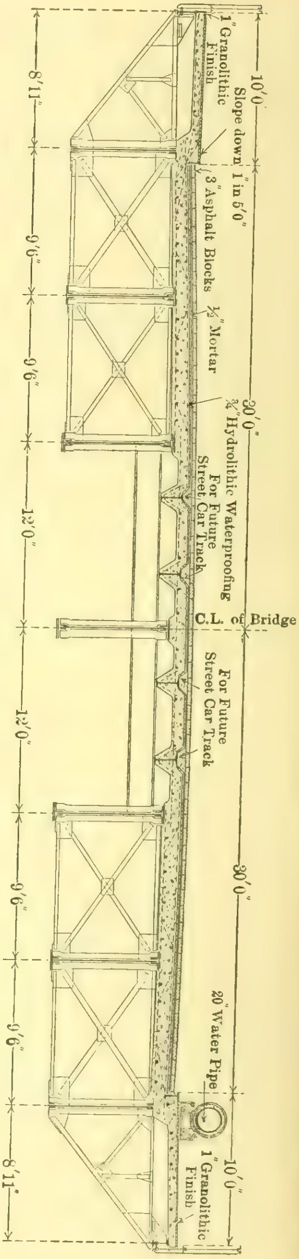


Fig. 3.—Bridge No. 4 About Completed.

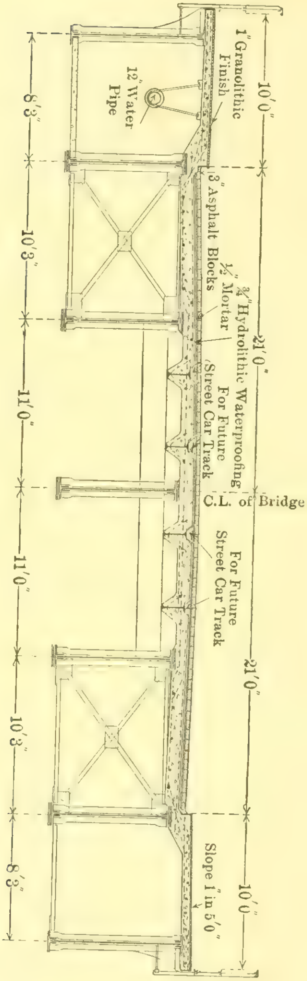


HIGHWAY BRIDGE
TYPICAL PANEL OF HAND-RAILING

Fig. 3.



THOMSON AVENUE BRIDGE.
CROSS-SECTION OF FLOOR IN SPAN NO. 4.



HONEYWELL STREET BRIDGE.
TYPICAL CROSS-SECTION.

FIG. 4.

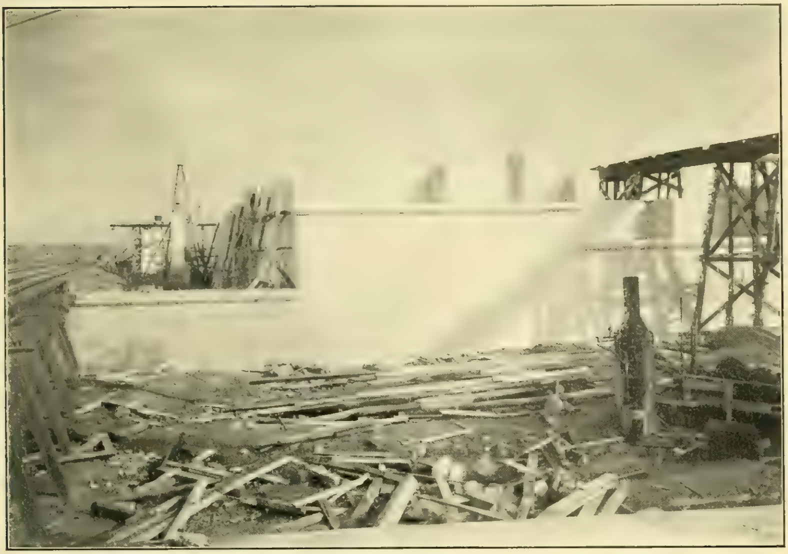


FIG. 1.—GOSMAN AVE. BRIDGE: MASONRY UNDER CONSTRUCTION.

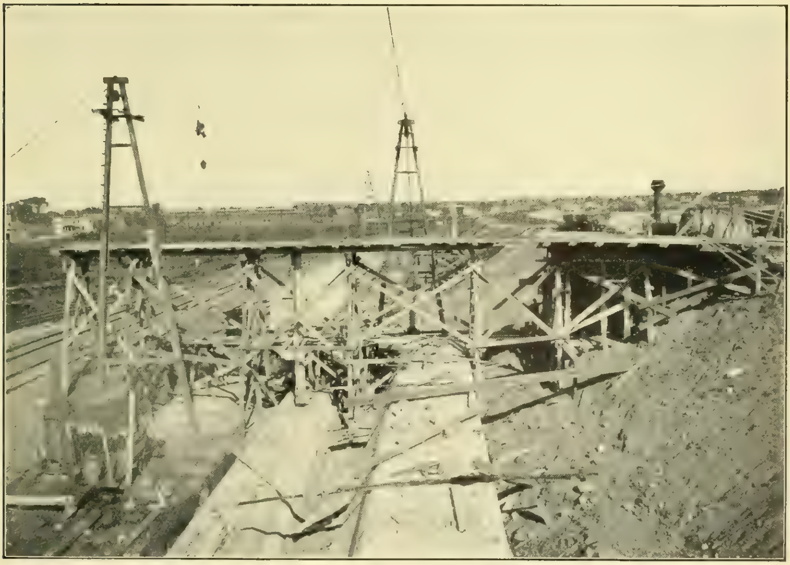
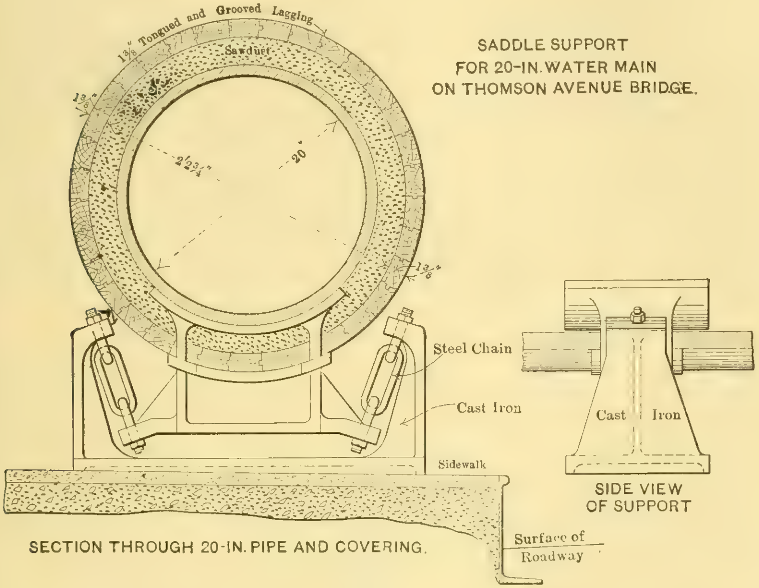


FIG. 2.—BRIDGE NO. 2: MASONRY UNDER CONSTRUCTION.

beneath the sidewalk, as shown by the cross-section of Honeywell Street Bridge, Fig. 4. These are sufficiently flexible to allow of considerable movement of the bridge at the expansion joints without affecting the pipe. In the case of Honeywell Street Bridge, however, which is 1 574 ft. long, two expansion pipe-joints were introduced.

Longitudinal elevations of the Bridge Approach Viaduct and Honeywell Street Bridge, together with cross-sections of the Yard are shown by Plate CLV.



SADDLE SUPPORT FOR 20-IN. WATER MAIN ON THOMSON AVENUE BRIDGE.

SECTION THROUGH 20-IN. PIPE AND COVERING.

SIDE VIEW OF SUPPORT

FIG. 5.

Railroad bridges of girder type for eight tracks were constructed over Gosman Avenue and Laurel Hill Avenue, and also over the four loop tracks. Four I-beam bridges, designated Nos. 1, 2, 4, and 5, for carrying railroad tracks over railroad tracks, were also constructed at various places in the Yard. All these railroad bridges have reinforced concrete floors, and are water-proofed with seven coats of pitch and six layers of felt, protected by one course of brick laid in cement. Fig. 2, Plate CLIV, Plate CLVI, and Fig. 1, Plate CLVII, show some of the highway and railroad bridges under construction. The general dimensions, and the quantities of materials used in the construction, of each highway and railroad bridge, are given in Tables 1 and 2.

TABLE 1.—HIGHWAY BRIDGES OVER SUNNYSIDE YARD: DIMENSIONS AND QUANTITIES OF MATERIALS.

Name of bridge.	Length, in feet.	Number of spans.	Roadway, width in feet.	Sidewalks, width in feet.	Total width of bridge, in feet.	Structural steel in superstructure, in pounds.	Steel reinforcing bars in floor, in pounds.	Steel reinforcing bars in protective piers, in pounds.	Steel reinforcing bars in substructure, in pounds.	Total steel, in pounds.	Concrete in floor, in cubic yards.	Concrete in protective piers, in cubic yards.	Concrete in substructure, in cubic yards.	Total concrete, in cubic yards.	Piles, total length, in feet.	Contractors for superstructures.
Thomson Ave.......	773	14	60	10	80	3 346 235	252 580	40 762	10 492	3 650 069	2 805	1 409	21 602	25 816	97 041	Pennsylvania Steel Company.
Bridge approach....	1 036	19	60	10	87	4 682 434	309 074	19 347	6 213	5 017 068	2 889	686	8 593	12 168	68 141	McClintic-Marshall Construction Company.
Honeywell St........	1 574	22	42	10	62	6 998 271	353 704	11 709	153	7 363 837	3 540	396	4 314	8 250	....	American Bridge Company.
Driveway to yard...	310	6	20	....	20											
Harold Ave. north..	361	7	42	10	62	3 128 657	151 729	17 391	1 171	3 298 948	2 059	577	4 436	7 072	....	Lewis F. Shoemaker and Company.
" " south..	528	9	42	10	62											
Total..........	......	..	....	....	....	18 155 597	1 067 087	89 209	18 029	19 329 922	11 293	3 068	38 945	53 306	165 182	

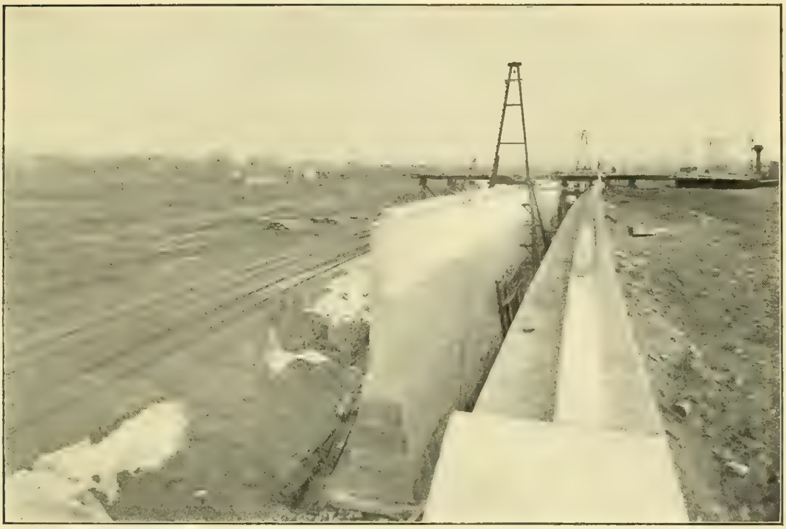


FIG. 1.—BRIDGE NO. 2: MASONRY UNDER CONSTRUCTION.

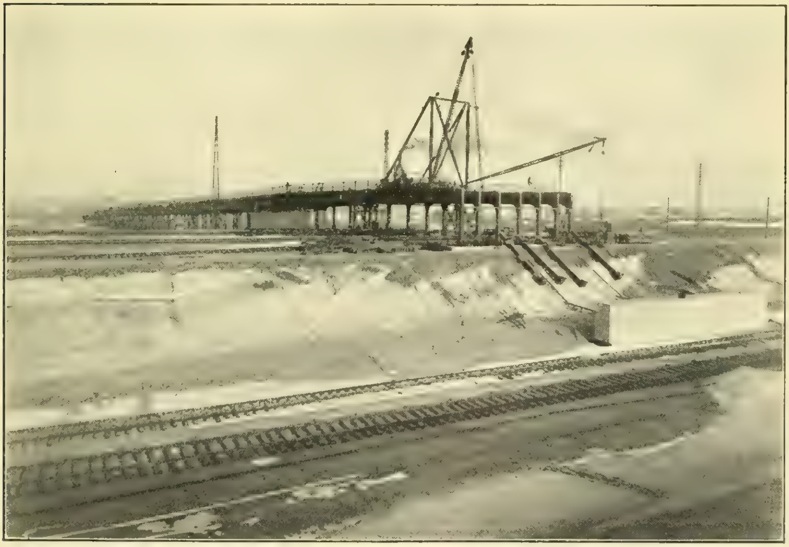


FIG. 2.—ERECTING SUPERSTRUCTURE, HONEYWELL ST. BRIDGE.

TABLE 2.—RAILROAD BRIDGES, SUNNYSIDE YARD: DIMENSIONS AND QUANTITIES OF MATERIALS.

Name of bridge.	Type of bridge.	Maximum length, in feet.	Number of spans.	Number of tracks.	Structural steel in superstructure, in pounds.	Steel reinforcing bars in floors, in pounds.	Steel reinforcing bars in protective piers, in pounds.	Steel reinforcing bars in substructure, in pounds.	Total steel, in pounds.	Concrete in floor, in cubic yards.	Concrete in protective piers, in cubic yards.	Concrete in substructure, in cubic yards.	Total concrete, in cubic yards.	Piles, total length, in feet.	Contractors for superstructures.
No. 1...........	I-beam........	96.5	1	1	76 200	3 350	....	12 250	91 800	235	....	4 600	4 835	......	Wilson and English Construction Company.
No. 2...........	" "	283.0	2	2	426 193	22 011	....	93 500	541 704	986	...	11 133	12 119	......	McClintic-Marshall Construction Company.
No. 4...........	" "	172.0	2	2	181 899	10 515	....	39 897	232 311	539	....	5 156	5 695	......	McClintic-Marshall Construction Company.
No. 5...........	" "	103.0	2	2	141 137	4 867	....	24 560	170 564	367	....	3 773	4 140	20 118	McClintic-Marshall Construction Company.
Laurel Hill Ave........	Deck girders, half-through girders......	188.5	4	8	1 643 142	103 600	191	25 596	1 772 529	810	19	6 742	7 571	......	McClintic-Marshall Construction Company.
Gosman Ave.	Deck girders, half-through girders......	108.5	3	8	1 005 796	50 422	269	10 381	1 066 868	517	20	5 339	5 876	......	McClintic-Marshall Construction Company.
Total.....	....	......	..	...	3 474 367	194 765	460	206 184	3 875 776	3 454	39	36 743	40 236	20 118	

NOTE.—Quantities of materials shown for Bridge No. 1 are approximate.

TRACKS.

In the final plan of the tracks between Thomson Avenue and Woodside Avenue, exclusive of the Yard addition shown in dotted lines, and the Long Island Railroad freight tracks north of the Yard, there are:

13.56 miles of main tracks.
39.62 miles of yard and yard-running tracks.

53.18 total miles of tracks.

285 No. 8 frogs.
13 No. 10 frogs.
7 No. 12 frogs.
35 No. 15 frogs.
1 double slip.

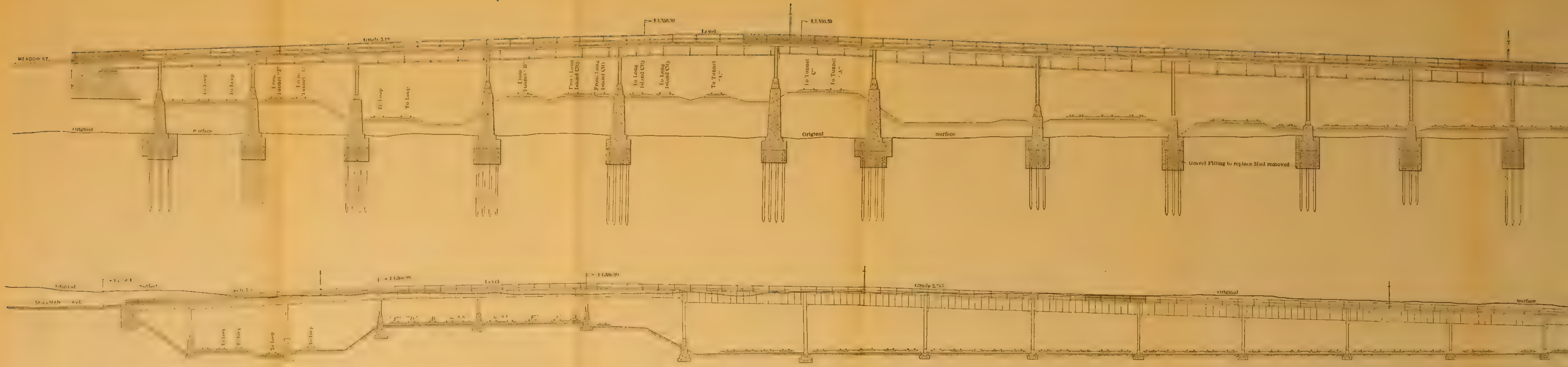
The main tracks and loop tracks are laid with 100-lb. rails supported on oak ties, with tie-plates. The yard and yard-running tracks are laid with 85-lb. rails on yellow pine ties, with tie-plates. All tracks throughout the Yard have an additional third-rail for supplying electric motive power.

An electric-pneumatic interlocking system has been installed at four points, and the necessary signal cabins and signals have been erected.

BUILDINGS.

In order to accommodate the necessary stores and plant required for the Yard, the following buildings have been erected under contract with the John W. Ferguson Company, of Paterson, N. J.:

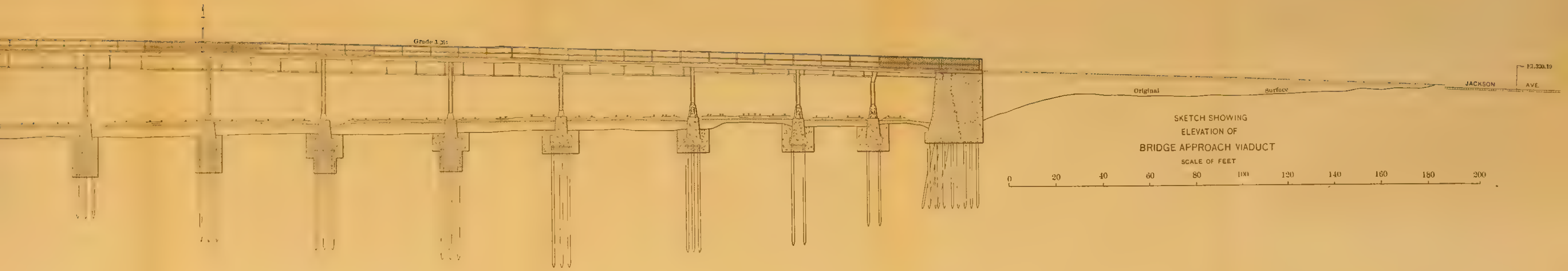
Stores and Commissary Building	258 ft.	by	67 ft.
Stores and Lavatory Building	162 ft.	"	67 ft.
Oil- and Lamp-House	67 ft.	"	51 ft.
Sand-House	32 ft.	"	25 ft.
Battery-Repair Building	103 ft.	"	67 ft.
Inspection Building	96 ft.	"	47 ft.
Boiler-House and Sub-station	233 ft.	"	51 ft.
Machine and Smith Shop	80 ft.	"	40 ft.
Inspection-Pit Shed	100 ft.	"	50 ft.
Three Signal Cabins	27 ft.	"	17 ft.
One Signal Cabin and Yard Building	84 ft.	"	14 ft.
Carpet Shed	88 ft.	"	33 ft.



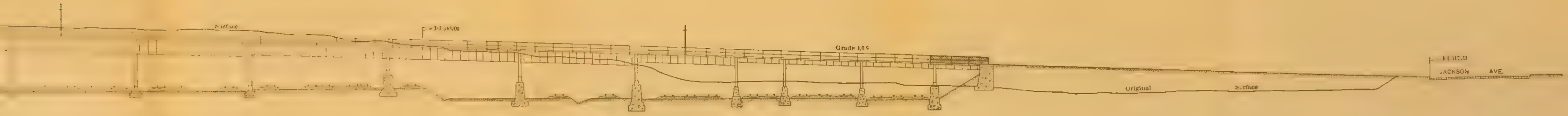
SKETCH SHOWING ELEVATION OF HONEYWELL STREET BRIDGE

SCALE OF FEET

0 40 80 120 160 200 240 280 320



SKETCH SHOWING
ELEVATION OF
BRIDGE APPROACH VIADUCT
SCALE OF FEET



TION OF HONEYWELL STREET BRIDGE

All these buildings have steel frames and roofs, and brick walls, except that the Inspection Building and the Machine and Smith Shop have plaster walls, and the Carpet Shed and the Inspection-Pit Shed have corrugated-iron sides. All buildings have concrete foundations.

The portion of the Stores and Commissary Building located over the swamp is supported on Chenoweth concrete piles, made by rolling woven wire of small mesh, reinforcing rods, and very dry concrete into a cylinder about 14 in. in diameter. A double water-jet and a pile-driver with a cushioned hammer weighing 4 600 lb. and having a maximum fall of 4 ft., were used in driving these piles. Two of the Signal Cabins are supported on wooden piles.

A brick-lined, steel stack, 200 ft. high, 12 ft. 8 in. at the bottom and 9 ft. 10 in. at the top (outside diameter), has been erected at the Boiler-House. Steel Umbrella Sheds, 20 ft. wide and having an aggregate length of 2 798 ft., have been erected between the tracks adjacent to the buildings. Fig. 2, Plate CLVII, is a view of the buildings as constructed.

Sewers.

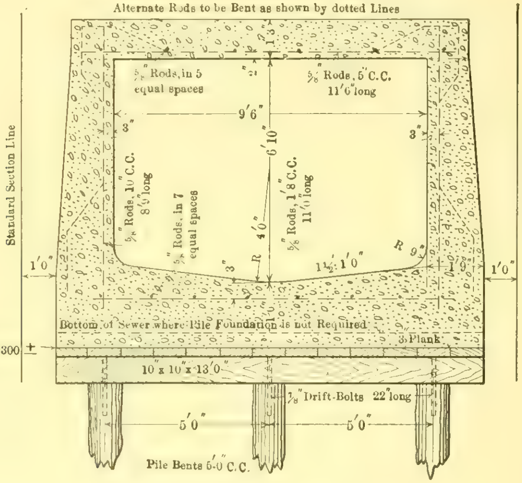
The slope and shape of the Yard caused the surface drainage to flow toward the tunnel portals, and it was necessary to intercept it by an adequate sewerage system before it reached these points. Two places of discharge have been used, and two sewer systems constructed: One system, receiving nothing but surface drainage, empties into Dutch Kills Creek, the other, receiving both house sewage and surface drainage, empties into the Webster Avenue sewer system at Payntar Avenue and Jackson Avenue. In some low parts of the Yard open sub-surface tile drains were used. As far as practicable, sewers were located so as to avoid the use of piles, but, across the swamp, both the concrete and iron-pipe sewers (except some of small section), are thus supported. When in close proximity to, or directly under, railroad tracks, the concrete sewers were increased in strength by additional reinforcement. The largest sewer is of square section, 9 ft. 6 in. by 6 ft. 10 in., Fig. 1, Plate CLVIII, and Fig. 6.

Fig. 7 shows plans and sections of sewers.

Water Supply.

To supply the great quantity of water required for the power-station and for Yard use, a number of wells, about 10 ft. square, from 30 to

40 ft. deep (equal to from 50 to 80 ft. below the original surface of the ground), were sunk through the sand and gravel in different parts of the Yard, and by pumping from them continuously, night and day, for one week, their capacity and the quality of the water were ascertained. The results having proved satisfactory in both respects, it was decided to use the water from one of the wells near Harold Avenue for all purposes of the Company in Long Island City. This well is 7 ft. 6 in. in diameter, and is lined with reinforced concrete, 1 ft. thick, resting on short piles driven below the bottom of the well. A test indicated that its maximum capacity was about 800 000 gal. per day. The pump will be placed in the Boiler-House, 2 347 ft. from the well.


Alternate Rods to be Bent as shown by dotted Lines
Standard Section Line
Standard Section Line
1'3"
5/8" Rods, in 5 equal spaces
5/8" Rods, 5" C.C. 11'0" long
9'6"
3"
3"
6'10"
5/8" Rods, 10" C.C. 8'9" long
5/8" Rods, in 7 equal spaces
4'0"
R
5/8" Rods, 1'8" C.C. 11'0" long
R 9"
3"
1½:1'0"
1'9"
1'0"
1'0"
Bottom of Sewer where Pile Foundation is not Required
3" Plank
El.300 ±
10" x 10" x 13'0"
7/8" Drift-Bolts 22" long
5'0"
5'0"
Pile Bents 5'0" C.C.

SECTION OF 9'6" CONCRETE SEWER ON PILES

Fig. 6.

Pipe Tunnel and Trenches.

On account of the great number of water, steam, gas, and air pipes throughout the Yard, they have been placed in concrete trenches so that they can be reached without difficulty for alteration or repair. For this purpose a concrete pipe tunnel, 8 ft. 6 in. by 6 ft. 0 in., and 603 ft. long (Fig. 8), leading from the Boiler-House and crossing the Yard at right angles to the line of tracks, and thirteen concrete pipe trenches, 2 ft. in clear width, of varying depth, and of a total length of 12 325 ft., connecting with the tunnel and running parallel with and between every other track, have been constructed. Embedded in

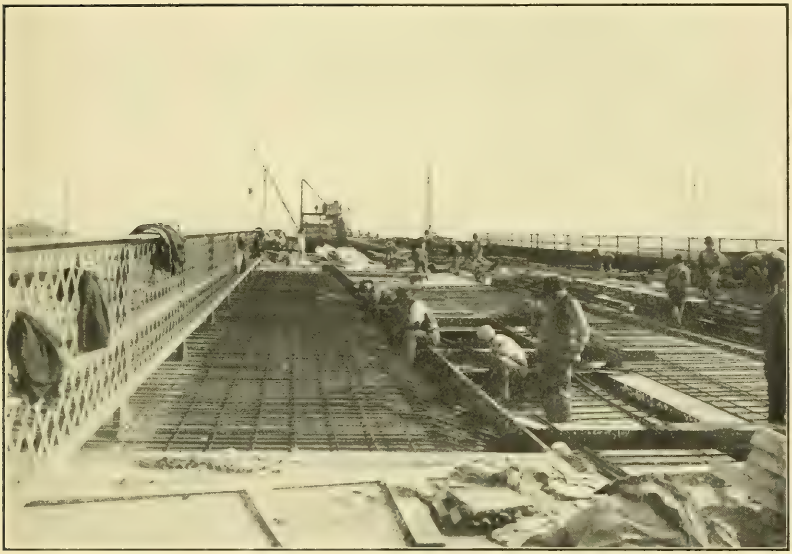


FIG. 1.—FLOOR REINFORCEMENT, BRIDGE APPROACH VIADUCT.

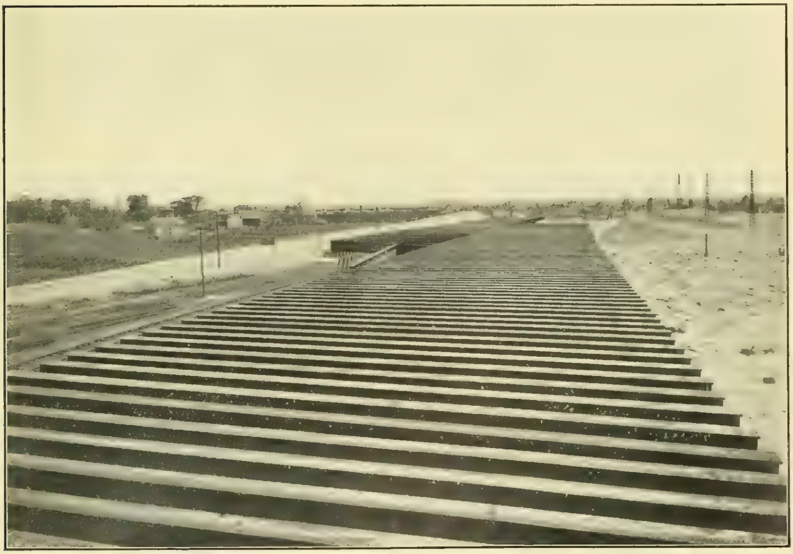


FIG. 2.—VIEW OF BRIDGE NO. 2 BEFORE PLACING CONCRETE FLOOR.

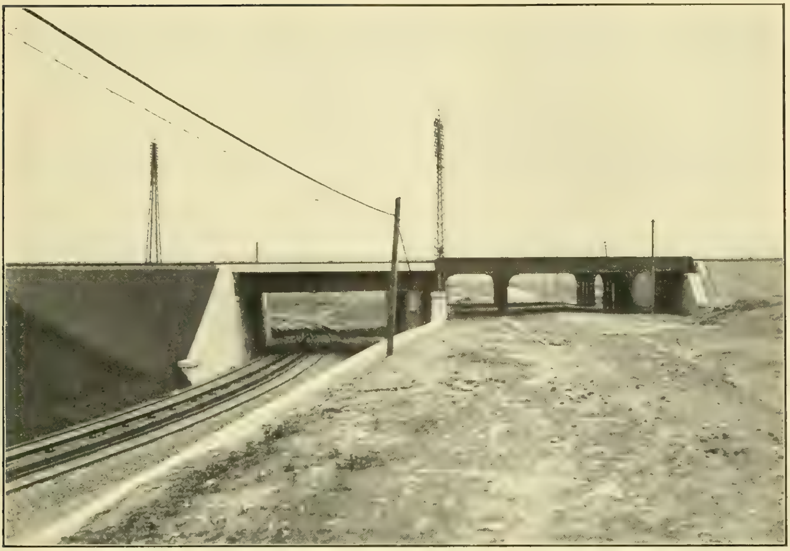


Fig. 1.—Railroad Bridge for Eight Tracks over Laurel Hill Ave. and the Loop Tracks.

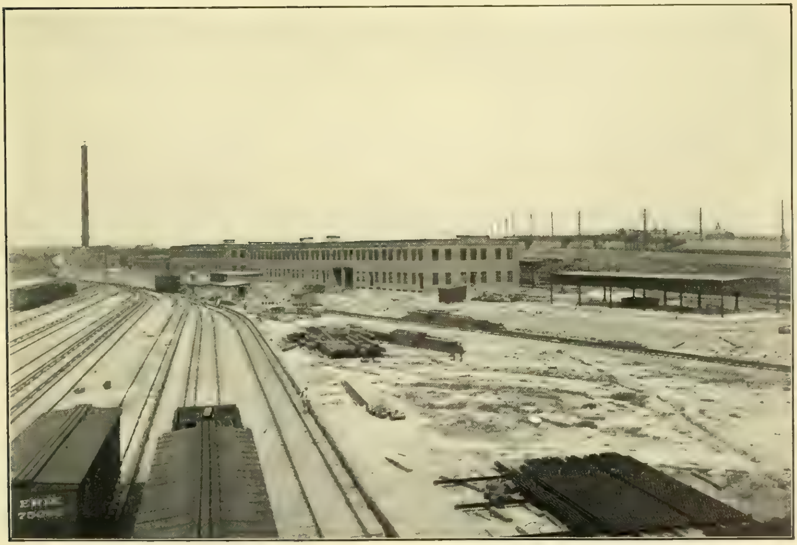
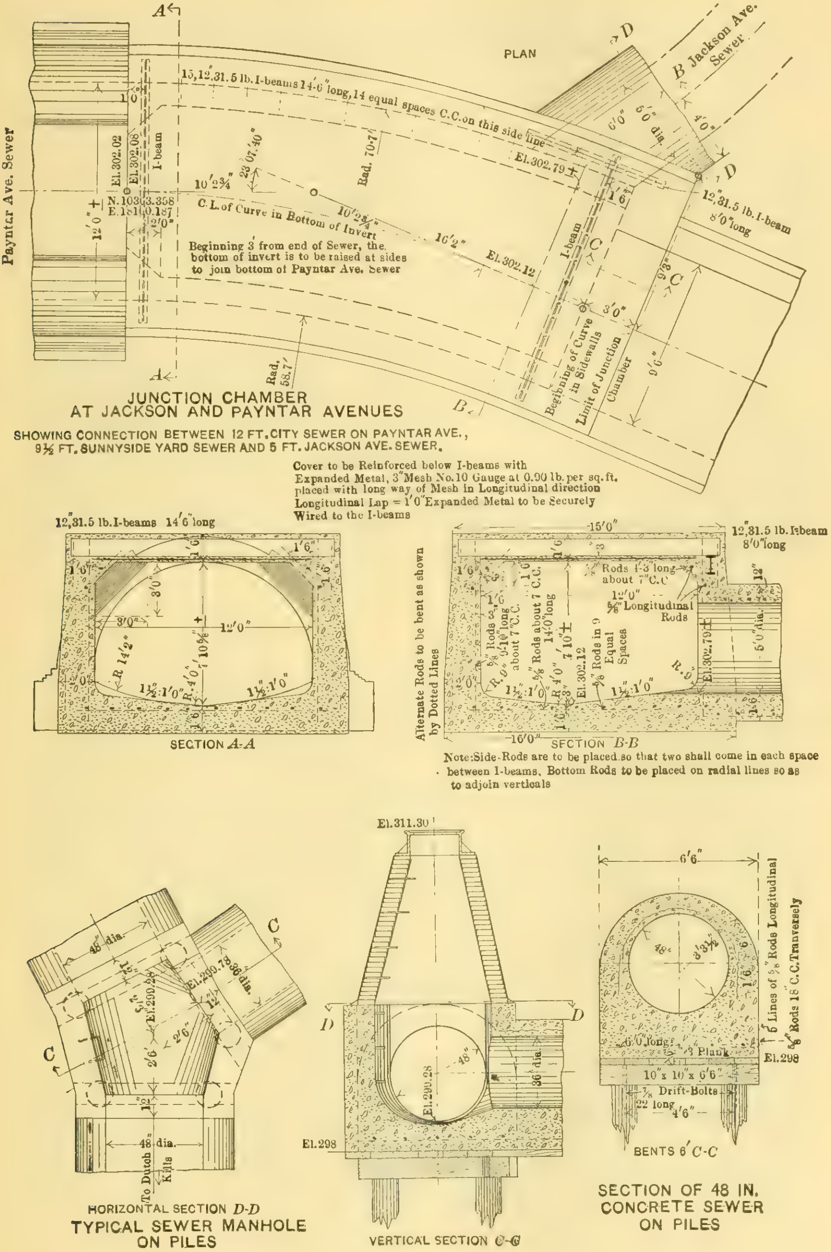


Fig. 2.—View of Yard Buildings under Construction.


PLAN
Payntar Ave. Sewer
B Jackson Ave. Sewer
15, 12" 31.5 lb. I-beams 14' 6" long, 14 equal spaces C.C. on this side line
12" 31.5 lb. I-beam 8' 0" long
El. 302.02
El. 302.08
El. 302.79
El. 302.12
N. 10363.358
E. 18110.187
I-beam
23' 07.40"
10' 2¾"
Rad. 70.7'
Rad. 58.7'
C.L. of Curve in Bottom of Invert
Beginning 3' from end of Sewer, the bottom of invert is to be raised at sides to join bottom of Payntar Ave. Sewer
6' 0" dia.
4' 0"
Beginning of Curve in Sidewalls
Limit of Junction Chamber
9' 6"
3' 0"
A
B
C
D
Cover to be Reinforced below I-beams with Expanded Metal, 3" Mesh No. 10 Gauge at 0.90 lb. per sq. ft. placed with long way of Mesh in Longitudinal direction Longitudinal Lap = 1' 0" Expanded Metal to be Securely Wired to the I-beams
12" 31.5 lb. I-beams 14' 6" long
R 14' 2"
12' 0"
1½ : 1' 0"
Alternate Rods to be bent as shown by Dotted Lines
15' 0"
16' 0"
Rods 4' 3" long about 7" C.C.
⅝" Longitudinal Rods
⅝" Rods about 7" C.C. 14' 0" long
⅝" Rods in 9 Equal Spaces
5' 0" dia.
Note: Side-Rods are to be placed so that two shall come in each space between I-beams. Bottom Rods to be placed on radial lines so as to adjoin verticals
El. 311.30
El. 290.28
El. 290.78
El. 298
48" dia.
36" dia.
To Dutch Kills
6' 6"
8' 3½"
5 Lines of ⅝" Rods Longitudinal
⅝" Rods 18" C.C. Transversely
6' 0" long
3" Plank
10" x 10" x 6' 6"
⅞ Drift-Bolts 22" long
4' 6"
BENTS 6' C-C

JUNCTION CHAMBER AT JACKSON AND PAYNTAR AVENUES

SHOWING CONNECTION BETWEEN 12 FT. CITY SEWER ON PAYNTAR AVE., 9½ FT. SUNNYSIDE YARD SEWER AND 5 FT. JACKSON AVE. SEWER.

SECTION *A-A*

SECTION *B-B*

HORIZONTAL SECTION *D-D*

TYPICAL SEWER MANHOLE ON PILES

VERTICAL SECTION *C-C*

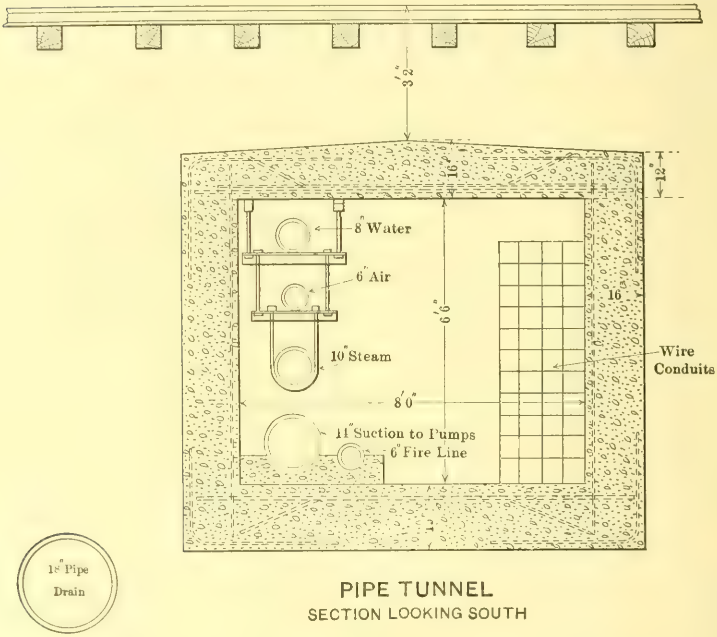
SECTION OF 48 IN. CONCRETE SEWER ON PILES

FIG. 7.

both sides of these trenches there are two 2½-in. and one 2-in. lines of fiber conduit for carrying wires. Fig. 2, Plate CLVIII, shows these pipe trenches before the 4-in. plank covering had been put in place.

The total quantity of cement used on all the work up to June 1st, 1910, was as follows:

Giant	125 108	bbl.
Atlas	8 245	"
Alsen (American)	8 047	"
Total	141 400	"



PIPE TUNNEL
SECTION LOOKING SOUTH

FIG. 8.

The entire Yard area will be enclosed by an iron picket fence, 7 ft. high, with 3-in. I-beam posts set in concrete bases.

An electrically-operated turn-table, 100 ft. in diameter, with concrete walls, has been built at the east end of the Yard.

The Sunnyside Yard was a section of the East River Division of the Tunnel Extension, and its construction was in charge of Alfred Noble, Past-President, Am. Soc. C. E., Chief Engineer from the beginning

PLATE CLVIII.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
BARKER ON
PENNSYLVANIA R. R. TUNNELS: THE SUNNYSIDE YARD.

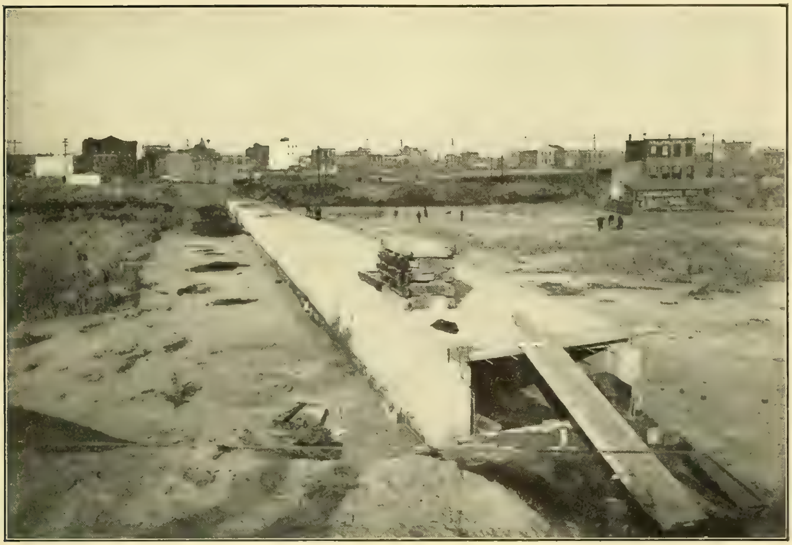


FIG. 1.—VIEW OF 9 FT. 6 IN. BY 6 FT. 10 IN. SEWER ON PILES, BEFORE COVERING.

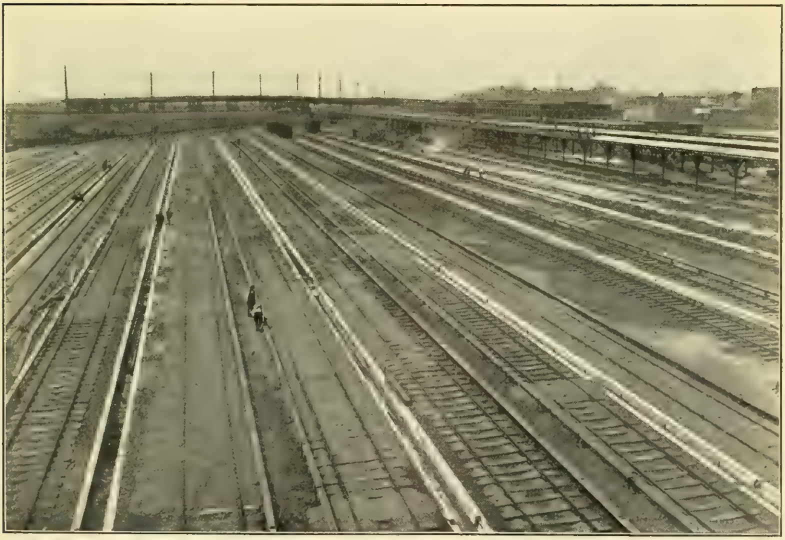


FIG. 2.—VIEW OF PIPE TRENCHES UNDER CONSTRUCTION.

of the work up to the time of his resignation, December 31st, 1909. Since that date George Gibbs, M. Am. Soc. C. E., Chief Engineer of Electric Traction and Station Construction, has had charge of the completion of this, as well as all other work in connection with the Yard.

F. M. Green, Assoc. M. Am. Soc. C. E., Designing Engineer in the office of the Chief Engineer, has furnished the information herein relative to the design of the bridges, and the loads and stresses assumed and used in their calculations.

Vol. XXXVI. AUGUST, 1910. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications

THE NEW YORK TUNNEL EXTENSION OF THE PENNSYLVANIA RAILROAD.
THE LINING OF THE FOUR PERMANENT SHAFTS OF THE EAST RIVER DIVISION.

By F. M. Green, Assoc. M. Am. Soc. C. E.

To be Presented September 21st, 1910.

The four shafts described in this paper were intended, not only to facilitate the construction of the tunnels, but to serve various purposes after their completion. It is of the latter that this paper treats.

The locations of the shafts are shown on Plates XIII and XIV* (accompanying the paper by Alfred Noble, Past-President, Am. Soc. C. E.). It will be seen that the shafts, being placed near the shore on each side of the river, divide the length of the tunnels into three portions: The first portion extends from the station at Seventh Avenue, under Manhattan Island, to the East River, the second lies almost wholly under the river, and the third extends from the river bank eastward under Long Island to the portals. This arrangement of shafts was advantageous for construction purposes. It possesses also some advantages from the point of view of the operation of the tunnels.

A description of these shafts, as used during the construction of the tunnels, is given in the paper† by Messrs. James H. Brace, Francis

---

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings,* and, when finally closed, the papers, with discussion in full, will be published in *Transactions.*

* *Transactions*, Am. Soc. C. E., Vol. LXVIII, pp. 71 and 73.

† *Transactions*, Am. Soc. C. E., Vol. LXVIII, p. 419.

PLATE CLIX.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
GREEN ON
PENN. R. R. TUNNELS:
SHAFT LINING, EAST RIVER DIVISION.

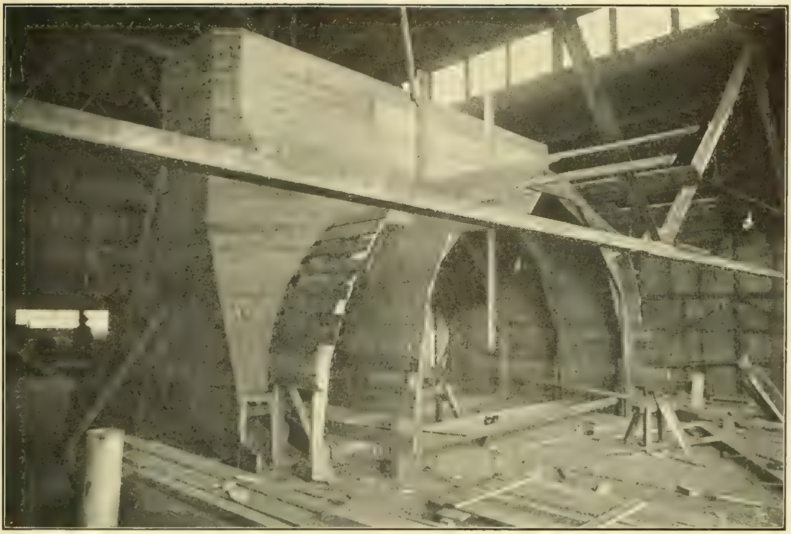


Fig. 1.—Form for Fresh-Air Ducts, Tunnel End.

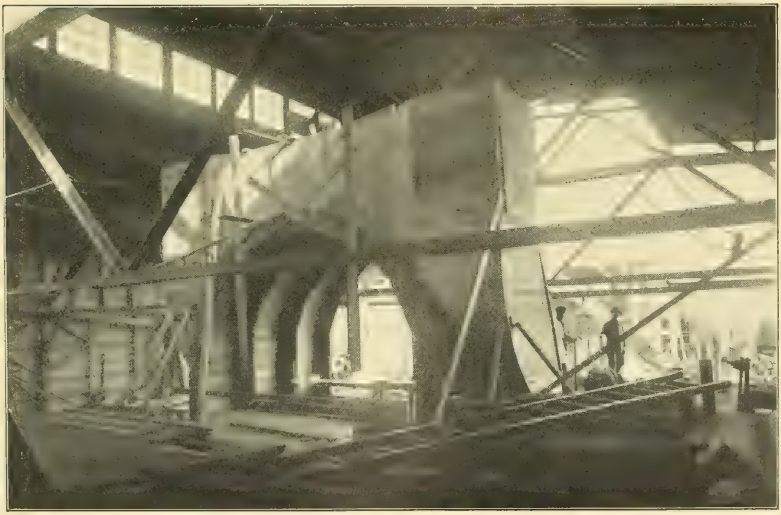


Fig. 2.—Form for Fresh-Air Ducts, Shaft End.

Mason, and S. H. Woodard, Members, Am. Soc. C. E. The work herein described was carried out after the completion of the tunnels.

During the operation of the tunnels the shafts will be required to perform the following functions:

1. To promote ventilation,
2. To provide access to and egress from the tunnels,
3. To permit electrical connections,
4. To provide for pump discharge.

The permanent lining of each shaft was designed to retain the sides of the shaft and to be of such form as to meet the requirements of the four functions mentioned above.

Ventilation is promoted by the piston action of the moving trains. When a train enters the tunnel a plenum is produced in front of the moving train. This region of plenum extends for a great distance in advance, in fact to the nearest shaft or portal. At each shaft a vertical opening 18 ft. in diameter was provided. As soon as a condition of plenum is produced in the tunnel by the entrance of a train, a strong upward current of air may be observed in the shaft. This continues while the train is approaching the shaft. A condition of partial vacuum exists in the tunnel in the rear of a departing train. As soon as a train has passed the shaft the current of air in the shaft is reversed. Fresh air continues to blow down the shaft until the train emerges from the tunnel at a portal, or until it passes another shaft.

Vertical openings have been provided in the shaft lining to serve as ducts for the mechanical injection of fresh air. This is delivered into the tunnels through nozzles which have been constructed in the sides of the tunnels where they pass out of the shafts. The nozzles are pointed in the direction of movement of the train, that is, they are pointed eastward in tunnels used for east-bound traffic and westward in tunnels used for west-bound traffic.

Access to and egress from the tunnels is provided for by three spiral stairways at each shaft. There is a bench on each side of each of the two tunnels that pass through a shaft. It is desirable to gain access to any bench without crossing a track. For this reason, in each shaft, one stairway was provided to the north bench of the north tunnel, one to the south bench of the south tunnel, and one to serve the adjacent benches of the two tunnels.

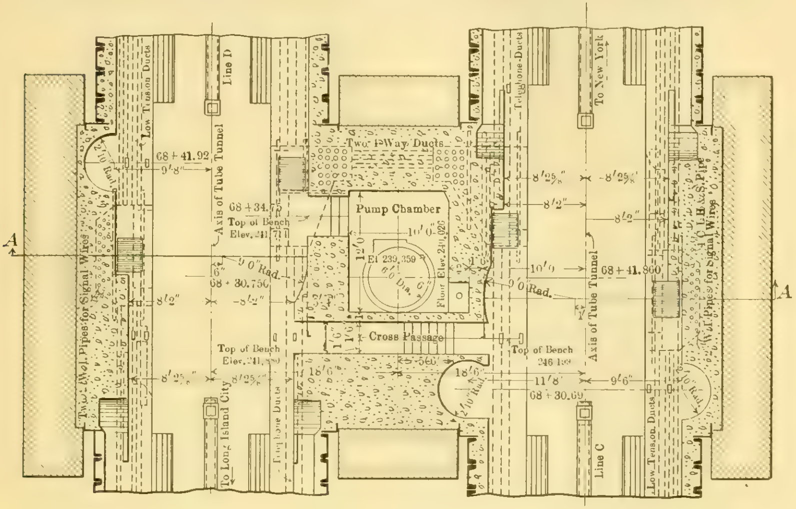
Wrought-iron pipes, $3\frac{1}{2}$ in. in diameter, for electric conduits, were embedded in the concrete of the shaft lining in a vertical position. In each shaft they were arranged in four groups, two for power cables and two for telephone and telegraph cables. The pipes for power cables were separated into sections by pockets left in the concrete, where provision was made for supporting the cables, thus reducing the weight of the cable suspended from the top. Wrought-iron pipes, 2 in. in diameter, were embedded in the concrete to serve as conduits for lighting and signal wires.

Water seeping into the tunnels, from the Station to the East River and from those under Long Island, runs down grade to the shafts, where it is collected in sumps under the tracks. From the sumps it is pumped to the tops of the shafts through cast-iron discharge pipes embedded in the concrete lining. The pumps are in pump-chambers formed in the concrete between the tunnels as shown in Fig. 1.

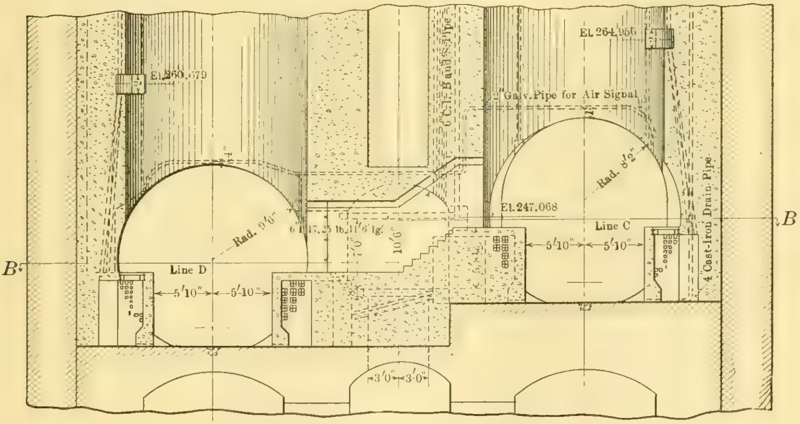
The concrete lining, as a retainer of the sides of the shaft, is illustrated in Fig. 2. This is a sectional plan of the South Manhattan shaft taken at a point a few feet above the tunnel roof. The fresh-air nozzles are shown in Fig. 3. In the Long Island shafts, the caissons were sunk to a point below the tunnels, while, in the Manhattan shafts the caissons were stopped in rock above the tunnel roof. These different types of construction are shown in Figs. 4 and 5. In the Long Island shafts, the inner shell of the caissons forms the water-proofing surface; in the Manhattan shafts, it was necessary to provide water-proofing below the caissons. With this end in view, a wall of concrete was built against the rock. When this had set, the forms were removed and the surface was plastered smooth with cement mortar. On the surface thus prepared, felt and pitch water-proofing was placed, six layers of felt and seven of pitch. Against the felt and pitch water-proofing the concrete of the shaft lining was deposited. This was required to be of such strength that it could safely withstand the pressure of water on the outside of the water-proofing, which, at the maximum depth, is probably not greater than 40 lb. per sq. in.

Some interesting problems arose in connection with the preparations for, and the construction of, the concrete wall upon which the felt and pitch water-proofing was to be placed. It was necessary that this wall should be dry before any hot pitch was placed upon it. Water was issuing from fissures in the rock at several points. At these

LONG ISLAND SHAFT. LINES C & D. CONSTRUCTION AT BENCH LEVEL.



SECTIONAL PLAN *B-B*



CROSS-SECTION *A-A*

FIG. 1.

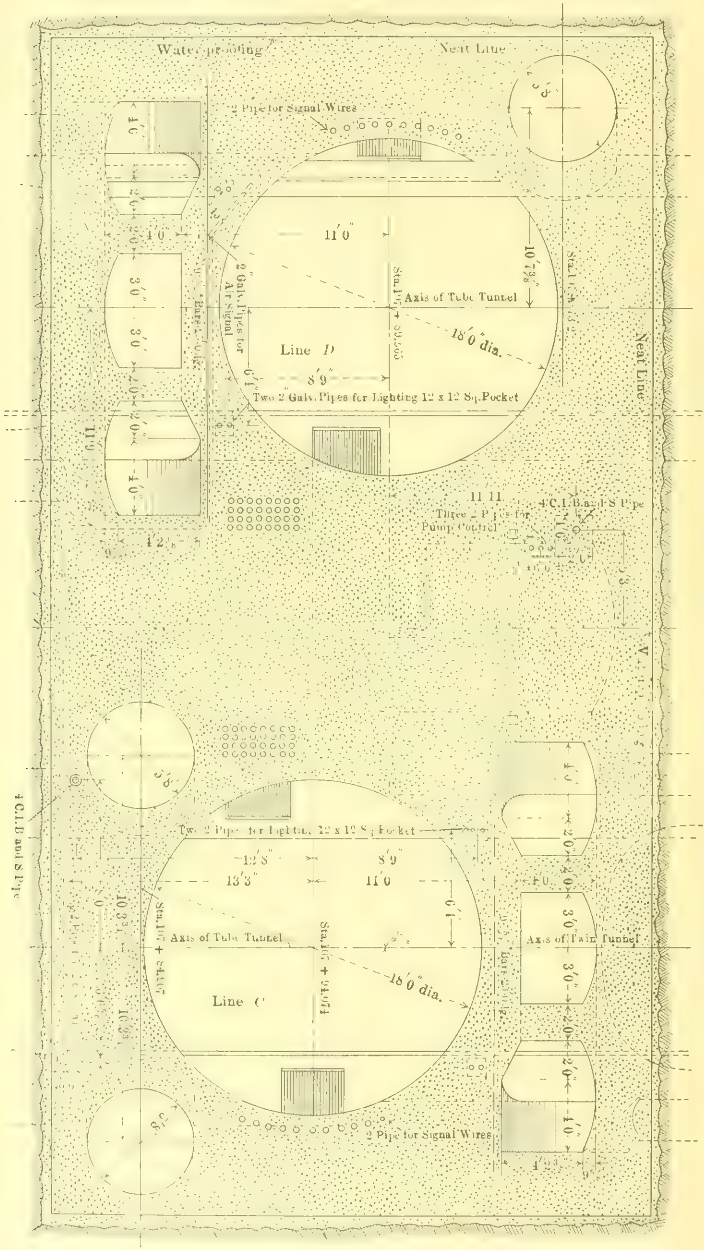
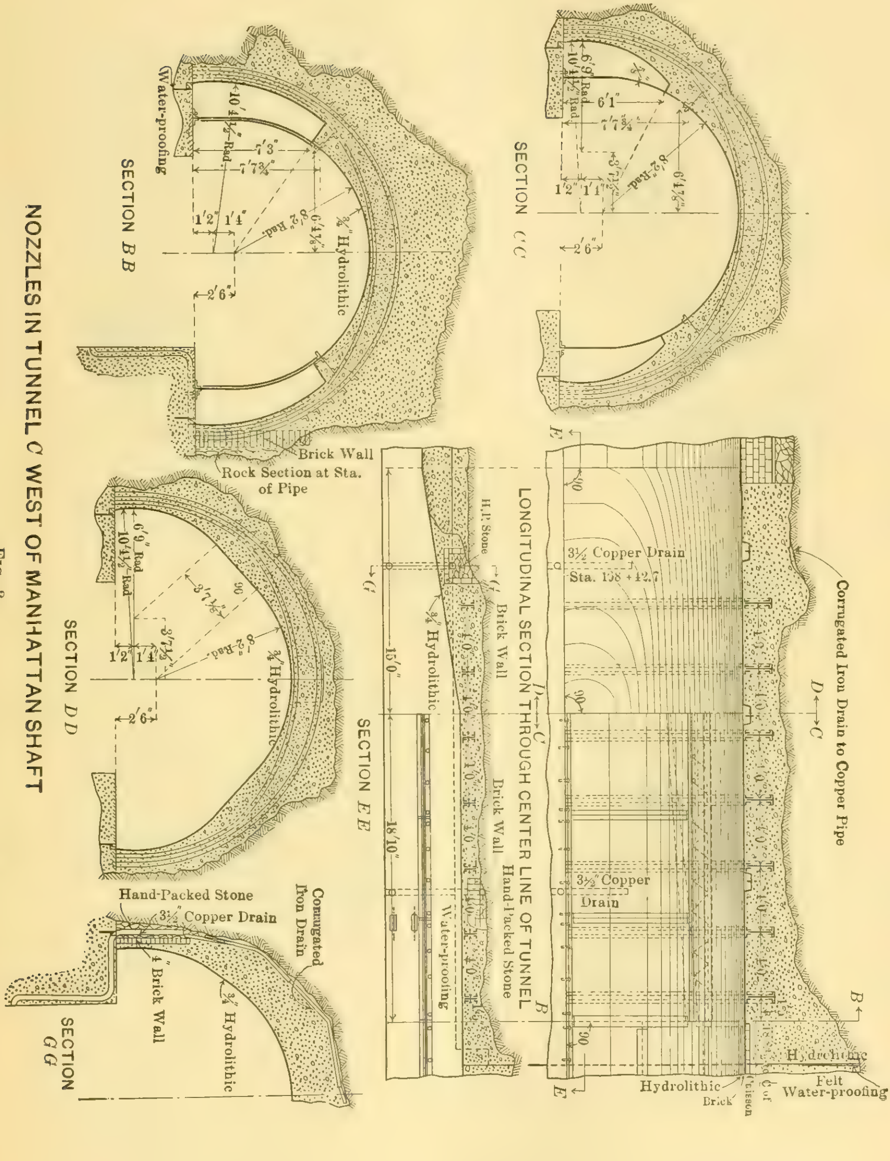


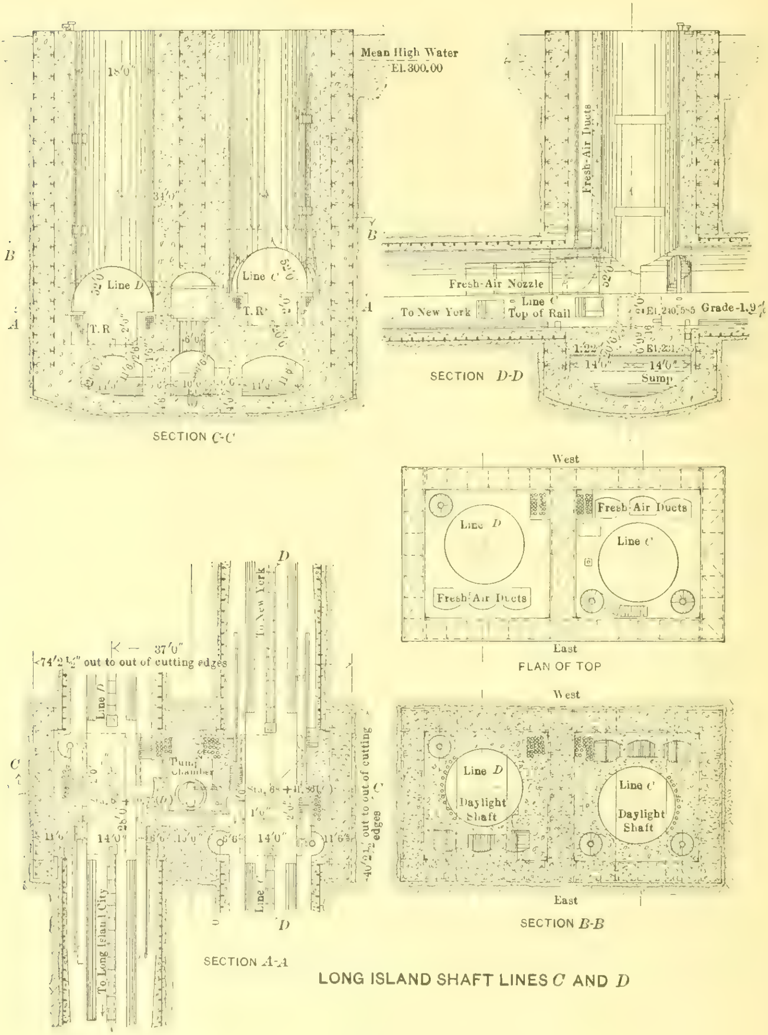
FIG. 2.

MANHATTAN SHAFT, LINES *C* AND *D*, SECTION ABOVE TUNNEL ROOF.



NOZZLES IN TUNNEL C WEST OF MANHATTAN SHAFT

Fig. 8.



SECTION C-C

SECTION D-D

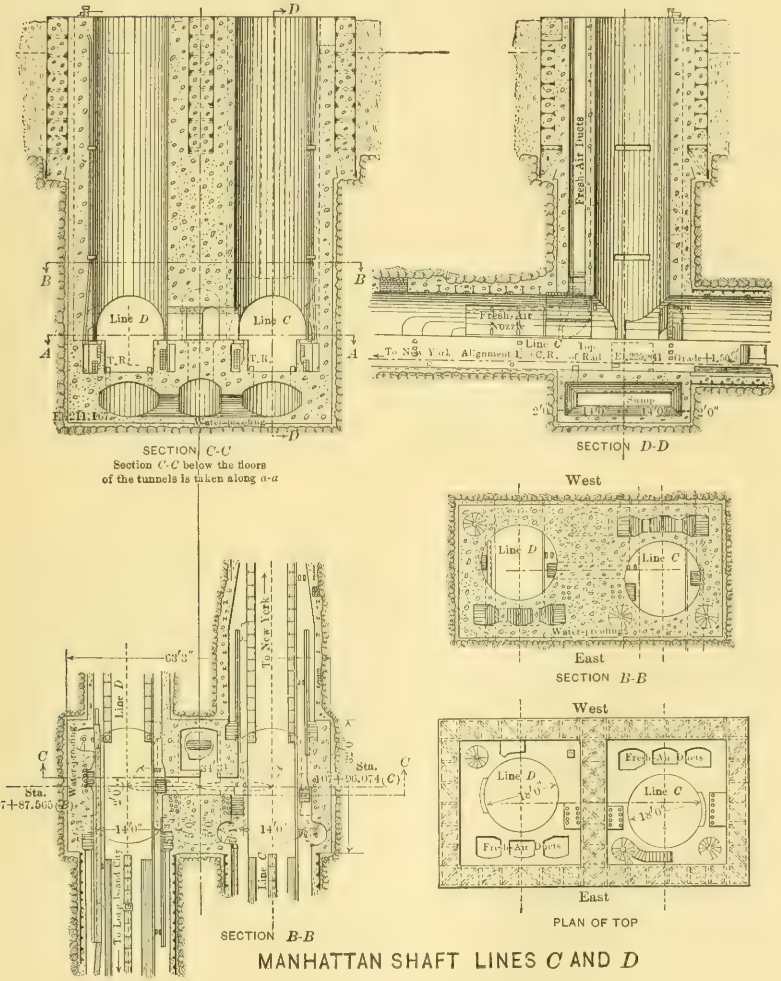
PLAN OF TOP

SECTION B-B

SECTION A-A

LONG ISLAND SHAFT LINES C AND D

FIG. 4.



MANHATTAN SHAFT LINES *C* AND *D*

FIG. 5.

fissures, vertical tile drains were built against the rock, and a short piece of pipe was run out horizontally from the base of each vertical drain to discharge the water beyond the face of the wall. A corrugated-iron roof was built over the location of the wall, to shed the water that dripped from above. After the concrete had been deposited and the forms had been stripped off, the felt and pitch water-proofing was placed, excepting over the small openings where the horizontal pipes issued from the wall. The water was allowed to run from these pipes, thus relieving the pressure at the back of the water-proofing, until everything was in readiness for depositing the concrete for the shaft lining. Then the pipes were plugged and patches of felt and pitch water-proofing were put over the holes, and at the same time the vertical pipes were poured full of pitch from above. The fresh concrete was deposited against the water-proofing as rapidly as practicable, so as to counteract the tendency of the water to accumulate outside and force the felt and pitch inward.

At the east face of the South Manhattan shaft, when making preparations to place the felt and pitch water-proofing, it became necessary to drain away water that was running down over the face of the wall from the exposed rock above. To accomplish this, a drain was constructed on the face of the wall near its top. This consisted of a strip of tin set in a ridge of plaster of Paris stuck on the face of the wall. The drain was nearly horizontal, but had a grade downward to the south. It answered the purpose very well, allowing the wall to dry out below the drain. This type of drain was found useful at many points. It could be applied quickly and at small cost.

The concrete lining had been placed in the iron-lined tunnels east of the Long Island shafts previous to the time when the design for the ventilating apparatus was determined upon. Therefore it became necessary to remove a sufficient quantity at the sides of the arches, in the two tunnels to be used for east-bound traffic, to provide space for the fresh-air nozzles.

It was considered unwise to use explosives in this work, on account of the danger of breaking the cast-iron segments.

By experiment it was found that the concrete could be broken out in fragments by the following process: Holes were drilled in the concrete, about 4 in. apart on a horizontal line, and perpendicular to the face. Parallel to the first row and about 8 in. above it, another row

PLATE CLX.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
GREEN ON
PENN. R. R. TUNNELS:
SHAFT LINING, EAST RIVER DIVISION.

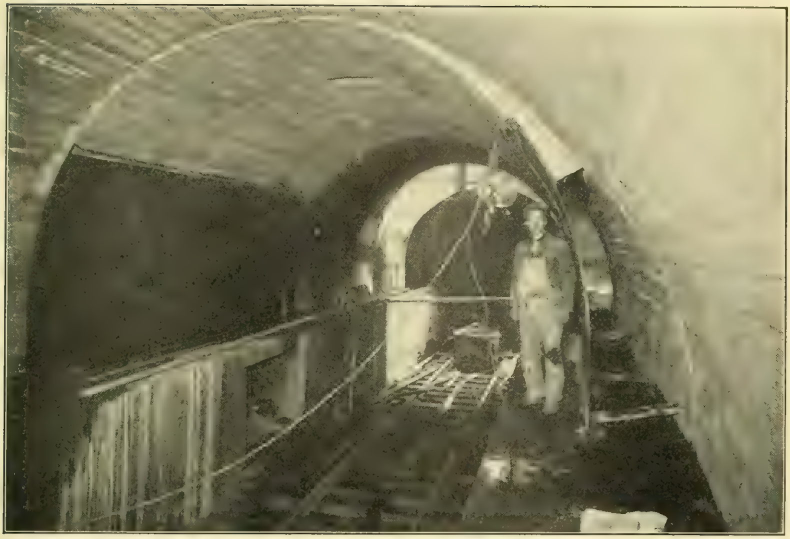


FIG. 1.—FRESH-AIR NOZZLES.

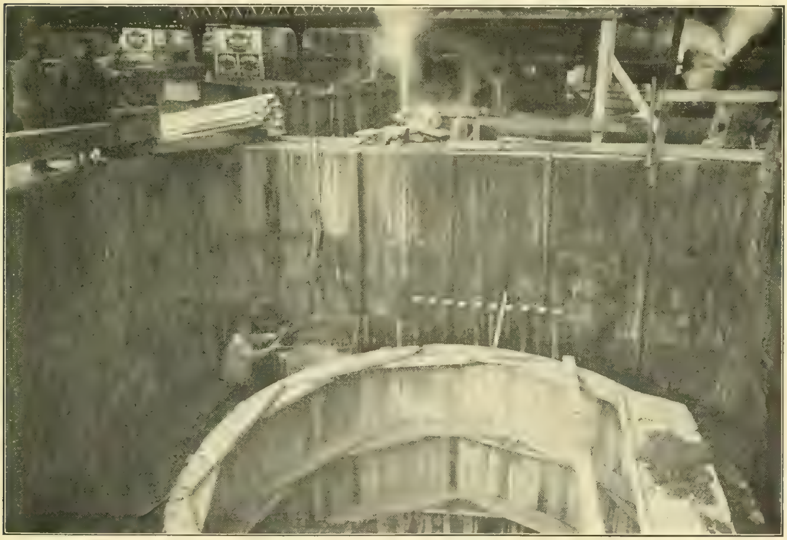


FIG. 2.—FORMS FOR OPEN WELL.

of holes was drilled, the holes being pointed downward at an angle of about 40 degrees. Steel wedges were driven into the upper holes, and resulted in breaking out wedge-shaped pieces of concrete. Another row of inclined holes was drilled about 8 in. above the second row. Steel wedges driven into the holes of this row broke out other fragments of concrete. This process was continued until the space for the nozzle was roughened out to approximately its final dimensions. It was then finished to nearly its final form by chisels operated by air hammers, and smoothed up with a stone-axe operated by hand.

In each tube this work required the removal of about 14 cu. yd. of material. The cost of this removal was about $72.50 per cu. yd., including the work of finishing the surface. The surface dressed was 515 sq. ft. The average depth of cutting was about 9 in. The cost was about $2 per sq. ft. of surface dressed, including the removal of material.

The construction herein described was done under contract by Fraser, Brace, and Company, of which both the President, Charles E. Fraser, and the Secretary, James H. Brace, are Members of the American Society of Civil Engineers. Work was started on September 27th, 1909.

The contractor's plant consisted of derricks, boilers, hoisting engines, narrow-gauge track, small dump-cars, rotary mixers, cement sheds, and other apparatus of the usual type.

Forms for splicing chambers, air-nozzles, and other parts were built in sections on the surface and lowered to position in the shafts.

Figs. 1 and 2, Plate CLIX, show some of these forms in process of construction. Fig. 1, Plate CLIX, is a view of the tunnel end of the form for the fresh-air ducts. The inner arch form has the dimensions of the intrados of the standard single-track tunnel under Manhattan. The outer arched form is for the outside of the air-nozzle. (See Fig. 1, Plate CLX.) The space between is the area available for the jet of air. The upper part of this form is to mould the base of the air ducts. Fig. 2, Plate CLIX, is a view of the shaft end of the same form. When this form was placed in position in the shaft, the lagging on the semicircular arch was replaced by the $\frac{5}{8}$-in. steel plates of the nozzles, forming a complete steel arch at the base of the air-ducts, as shown in the background in Fig. 1, Plate CLX. It will be seen that the fresh air, on arriving at the top of the tunnel on its way down the shaft, is separated into two streams, one going into the nozzle on the north side of the tunnel and the other into the nozzle on the south side. Fig. 1, Plate CLIX, is a view of the fresh-air duct at the roof of the tunnel.

Fig. 2, Plate CLX, shows the forms used in constructing the open wall, 18 ft. in diameter. The form here shown was 8 ft. deep. It was set at a higher elevation for each additional section of concrete. In this view it is near the top of the North Manhattan shaft.

The concrete in the lower portions of the shaft lining was mixed in the proportions of 1 part cement, 2½ parts sand, and 5 parts stone.

The sand and stone were measured in a steel dump-car. A partition was constructed across the hopper, dividing it into two portions, one containing 6.55 cu. ft. and the other 13.10 cu. ft. Three bags, or 285 lb., of cement were used with each car of sand and stone.

The concrete in the upper portions of the shaft lining (above a horizontal plane 3 ft. above the tunnel roof) was mixed in the proportions of 1 part cement to 3 parts sand, and 6 parts stone. Each batch contained 7.86 cu. ft. of sand, 15.72 cu. ft. of stone, and three bags, or 285 lb., of cement. A portion of this concrete was mixed in 4-bag batches, each batch containing 10.5 cu. ft. of sand, 21.0 cu. ft. of stone, and four bags, or 380 lb., of cement.

Fresh-air nozzles were constructed in the tunnels immediately west of the Manhattan shafts, in Lines *A* and *C*. The tunnels were excavated to full section in rock. The roofs were then constructed as shown in Fig. 3. The fresh-air nozzles, being formed in the side-walls of the arch, cut away the skewback and haunches of the arches to such an extent that it was deemed wise to reinforce the concrete arch with steel ribs built of plates and angles. These are shown in Fig. 3.

The interior of the concrete arch was thoroughly water-proofed with Hydrolithic water-proofing. In addition to this, copper drain-pipes, 3½ in. in diameter, were placed in the positions shown on the plans, the inlet end of each copper pipe being a chamber, with brick walls built against the rock at points where running water was found. The chamber was filled with broken stone. At one point where running water was encountered in the roof, a drain was constructed by hanging sheets of corrugated iron against the rock surface and training them so as to run the water into the rock-packed chamber. The sheets of corrugated iron were clamped securely to the rock by anchor-bolts set

PLATE CLXI.
PAPERS, AM. SOC. C. E.
AUGUST, 1910.
GREEN ON
PENN. R. R. TUNNELS:
SHAFT LINING, EAST RIVER DIVISION.

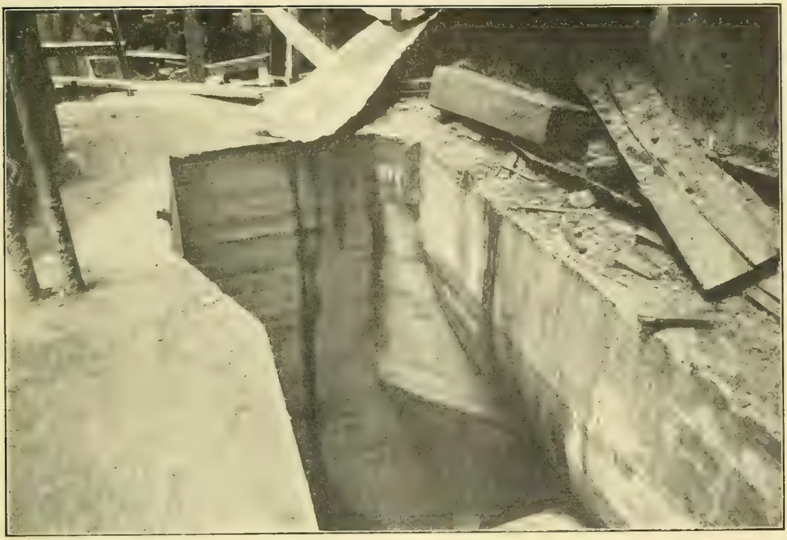


Fig. 1.—Fresh-Air Duct.

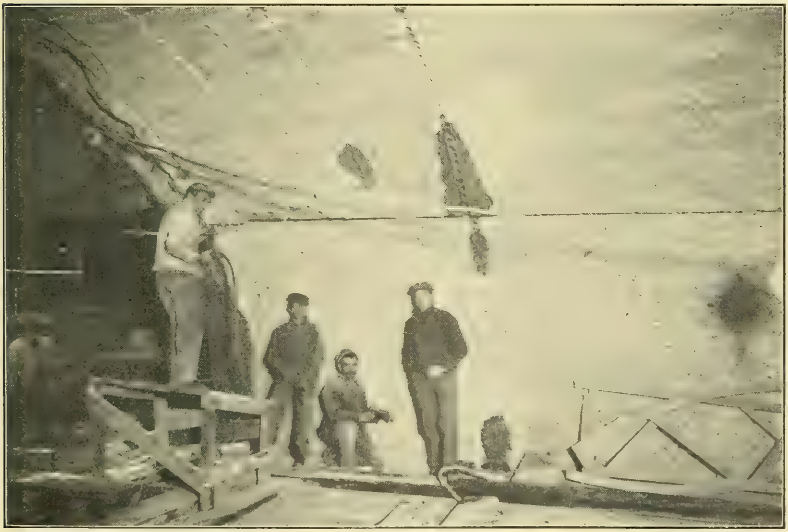


Fig. 2.—Removing Concrete from Tube Tunnel.

in holes drilled in the rock. The corrugation formed the channels for conveying the water. The sides and ends of the corrugated-iron drain were thoroughly and carefully sealed with Portland cement mortar so as to prevent any grout from entering the drain while the concrete was being placed. The measures taken to drain away the water from the wet spots in the rock appear to have been adequate, as water is flowing from the lower ends of the copper pipes, and no moisture is to be seen at these points in the tunnel roof.

At the east end of the Manhattan shaft the felt and pitch water-proofing of the shaft was connected to the cast-iron tunnel lining so as to make the water-proofing surface continuous. A coating of hot pitch was applied to the flange of the tube tunnel. The felt was lapped over this and securely clamped in place by steel plates bolted on with 1¼-in. bolts.

The felt and pitch water-proofing of the shaft was carried up on all four sides of the shaft to a point 7 ft. above the cutting edge of the caisson. Above this elevation, the inner steel plates of the caisson constitute the water-proofing.

The spiral stairways were constructed in circular wells, 5 ft. 8 in. in diameter, formed in the concrete. No attempt was made to form steps in the concrete, or to place supporting brackets, during the construction of the wells. This made the operation of setting the forms for the wells very simple.

The stairs were constructed of cast iron; the treads, carriers, and newel posts being cast and machined to standard patterns and templets. The twelve stairways have an aggregate height of 831 ft.; they contain 1 224 carriers, all alike, and 1 172 treads, all alike. The rise of each stair was divided into flights by landings placed at intervals of about 11 ft. 4 in. Each landing occupies a quadrant of a circle. The inner end of each tread is supported by the newel post, the outer end by the carrier. A supporting bracket was bolted to the concrete at each side of each landing, and also under one of the carriers about midway between landings.

The last batch of concrete was placed on March 11th, 1910. The work on the permanent structure was completed on May 31st, 1910, on which date the spiral stairways were finished.

The principal items of the permanent linings of these shafts comprise:

12 500	cu. yd. concrete,
14 400	sq. ft. of felt and pitch water-proofing,
5 000	sq. ft. of Hydrolithic water-proofing,
73 600	lb. steel, reinforcing concrete,
196 000	lb. steel in ventilator nozzles,
26 400	lin. ft. of steel pipe,
12 000	lb. of cast-iron pipe,
12 400	duct ft. of vitrified electric conduits,
132 400	lb. cast-iron spiral stairways.

Vol. XXXVI. AUGUST, 1910. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

PRESSURE RESISTANCE AND STABILITY OF EARTH.

Discussion.*

By Messrs. T. Kennard Thomson, Charles E. Gregory, Francis W. Perry, E. P. Goodrich, Francis L. Pruyn, and Frank H. Carter.

Mr. Thomso

T. Kennard Thomson, M. Am. Soc. C. E.—Although the author deserves great credit for the careful and through manner in which he has handled this subject, his paper should be labeled "Dangerous for Beginners," especially as he is an engineer of great practical experience; if he were not, comparatively little attention would be paid to his statements. The paper is dangerous because many will read only portions of it, or will not read it thoroughly. For instance, at the beginning, the author cites several experiments in which considerable force is required to start the lifting of a weight or plunger in sand and water and much less after the start. This reminds the speaker of the time when, as a schoolboy, he tried to pick up stones from the bottom of the river and was told that the "suction" was caused by atmospheric pressure.

The inference is that tunnels, etc., in sand, etc., are not in any danger of rising, even though they are lighter than water. Toward the end of the paper, however, the author states that tunnels should be weighted, but he rather spoils this by stating that they should be weighted only enough to overcome the actual water pressure, that is, between the voids of the sand. It seems to the speaker that the only really safe way is to make the tunnel at least as heavy as the water displaced in order to prevent it from coming up, and to take other

---

* This discussion (of the paper by J. C. Meem, M. Am. Soc. C. E., printed in *Proceedings* for April, 1910, and presented at the meeting of May 18th, 1910) is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

Mr. Thomson. measures to prevent it from going down. The City of Toronto, Canada, formerly pumped its water supply through a 6-ft. iron pipe, buried in the sand under Toronto Bay and then under Toronto Island, with an intake in the deep water of the lake. During a storm a mass of seaweed, etc., was washed against the intake, completely blocking it, and although the man at the pumping station knew that something was wrong, he continued to pump until the water was drawn out of the pipe, with the result that about ½ mile of the conduit started to rise and then broke at several places, thus allowing it to fill with water. Eventually, the city went down to bedrock under the Bay for its water tunnel.

Another reason for calling this paper dangerous for beginners is that it is improbable that experienced engineers or contractors will omit the bracing at the bottom, although, since the paper was printed, a glaring instance has occurred where comparatively little bracing was put in the bottom of a 40-ft. cut, the result being a bad cave-in from the bottom, although all the top braces remained in place. Most engineers will agree that nearly every crib which has failed slipped out from the bottom, and did not turn over.

The objection to the angle of repose is that it is not possible to ascertain it for any material deposited by Nature. It could probably be ascertained for a sand bank deposited by Man, but not for an excavation to be made in the ground, for it is known that nearly all earth, etc., has been deposited under great pressure, and is likely to be cemented together by clay, loam, roots, trees, boulders, etc., and differs in character every few feet.

A deep vertical cut can often be made, even in New York quicksand, from which the water has been drawn, and, if not subjected to jars, water, etc., this material will stand for considerable time and then come down like an avalanche, killing any one in its way. In such cases very little bracing would prevent the slide from starting, provided rain, etc., did not loosen the material.

The author, of course, treats dry and wet materials differently, but there are very few places where dry material is not likely to become wet before the excavation is completed.

In caisson work, if the caisson can be kept absolutely plumb, it can be sunk without having to overcome much friction, while, on the other hand, if it is not kept plumb, the material is more or less disturbed and begins to bind, causing considerable friction. The author claims that the pressure does not increase with the depth, but all caisson men will probably remember that the friction to be overcome per square foot of surface increases with the depth.

In calculating retaining walls, many engineers add the weight of the soil to the water, and calculate for from 90 to 100 lb. per cu. ft. The speaker is satisfied that in the so-called New York quicksand it is sufficient to use the weight of the water only. If the sand increased

Mr. Thomson.

the side pressure above the water pressure, engineers would expect to use more compressed air to hold it back, while, as a matter of fact, the air pressure used seldom varies much from that called for by the hydrostatic head.

Although allowance for water pressure is sufficient for designing retaining walls in New York quicksand, it is far from sufficient in certain silty materials. For instance, in Maryland, a coffer-dam, excavated to a depth of 30 ft. in silt and water, had the bottom shoved in 2 ft., in spite of the fact that the waling pieces were 5 ft. apart vertically at the top and 3 ft. at the bottom, and were braced by 12 by 12-in. timbers, every 7 ft. horizontally. The walings split, and the cross-braces cut into the waling pieces from 1 to 2 in.; in other words, the pressure seemed to be almost irresistible. This is quite a contrast to certain excavations in Brooklyn, which, without any bracing whatever, were safely carried down 15 ft.

Any engineer who tries to guess at the angle of repose, and, from the resulting calculations, economizes on his bottom struts, will find that sooner or later an accident on one job will cause enough loss of life and money to pay for conservative timbers for the rest of his life. So much for side pressures. As to the pressure in the roof of a tunnel, probably every engineer will agree that almost any material except unfrozen water will tend to arch more or less, but how much it is impossible to say. It is doubtful whether any experienced engineer would ever try to carry all the weight over the roof, except in the case of back-fill, and even then he would have to make his own assumption (which sounds more polite than "guess").

The author has stated, however, that when the tunnel roof and sides are in place, no further trouble need be feared. On the contrary, in 1885, the Canadian Pacific Railroad built a tunnel through clayey material and lined it with ordinary 12 by 12-in. timber framing, about 2 or 3 ft. apart. After the tunnel was completed, it collapsed. It was re-excavated and lined with 12 by 12-in. timbers side by side, and it collapsed again; then the tunnel was abandoned, and, for some 20 years, the track, carried around on a 23° curve, was used until a new tunnel was built farther in. This trouble could have been caused either by the sliding or swelling of the material, and the speaker is inclined to believe that it was caused by swelling, for it is known, of course, that most material has been deposited by Nature under great pressure, and, by excavating in certain materials, the air and moisture would cause those materials to swell and become an irresistible force.

To carry the load, Mr. Meem prefers to rely on the points of the piles rather than the side friction. In such cases the pile would act as a post, and would probably fail when ordinarily loaded, unless firmly supported at the sides. The speaker has seen piles driven from 80 to 90 ft. in 10 min., which offered almost no resistance, and yet, a

Mr. Thomson. few days later, they would sustain 40 tons each. No one would dream of putting 40 tons on a 90-ft. pile resting on rock, if it were not adequately supported.

It is the speaker's opinion that bracing should not be omitted for either piles or coffer-dams.

Mr. Gregory. CHARLES E. GREGORY, ASSOC. M. AM. SOC. C. E.—In describing his last experiment with the hydraulic chambers and plunger, Mr. Meem states that, after letting the pressure stand at 25 lb., etc., the piston came up. This suggests that the piston might have been raised at a much lower pressure, if it had been allowed to stand long enough.

The depth and coarseness of the sand were not varied to ascertain whether any relation exists between them and the pressure required to lift the piston. If the pressure varied with the depth of sand, it would indicate that the reduction was due to the resistance of the water when finely divided by the sand; if it varied with the coarseness of the sand, as it undoubtedly would, especially if the sand grains were increased to spheres 1 in. in diameter, it would show that it was independent of the voids in the sand, but dependent on dividing the water into thin films.

The speaker believes that the greater part of the reduction of pressure on the bottom of the piston might be better explained by the viscosity of the water, than to assume that a considerable part of the plunger is not in contact with it. The water, being divided by fine sand into very thin films, has a tensile strength which is capable of resisting the pressure for at least a limited time.

If the water is capable of exerting its full hydrostatic pressure through the sand, the total pressure would be the full hydrostatic pressure on the bottom of the piston where in contact, and, where separated from it by a grain of sand, the pressure would be decreased only by the weight of the grain. If a large proportion of the top area of a grain is in contact, as assumed by the author, this reduction of pressure would be very small. A correct interpretation can be obtained only after more complete experiments have been made.

For horizontal pressures exerted by saturated sands on vertical walls, it has not been demonstrated that anything should be deducted from full water pressure. No matter how much of the area is in direct contact with the sand rather than the water, the full water pressure would be transmitted through each sand grain from its other side and, if necessary, from and through many other grains which may be in turn in contact with it. The pressure on such a wall will be water pressure over its entire surface, and, in addition, the thrust of the sand after correcting for its loss of weight in the water.

The fact that small cavities may be excavated from the sides of trenches or tunnels back of the sheeting proves only that there is a local temporary arching of the material, or that the cohesion of the particles is sufficient to withstand the stress temporarily, or that

Mr. Gregory.

there is a combination of cohesion and arching. The possibility of making such excavations does not prove that pressure does not exist at such points. That sand or earth will arch under certain conditions has long been an accepted fact. The sand arches experimented with developed their strength only after considerable yielding and, therefore, give no index of the distribution or intensity of stress before such yielding. Furthermore, sand and earth in Nature are not constrained by forms and reinforcing rods.

Mr. Meem's paper is very valuable in that it presents some unusual phenomena, but many of the conclusions drawn therefrom cannot be accepted without further demonstration.

Mr. Perry.

FRANCIS W. PERRY, ASSOC. M. AM. SOC. C. E.—Pressure-gauge observations on a number of pneumatic caissons recently sunk, through various grades of sand, to rock at depths of from 85 to 105 ft. below ground-water, invariably showed working-chamber air-pressures equal, as closely as could be observed, to the hydrostatic pressures computed, for corresponding depths of cutting-edge, as given in Table 2.

TABLE 2.—EQUIVALENT FEET OF DEPTH BELOW WATER PER POUND PRESSURE.

Pressure, in pounds.	Equivalent feet of depth.	Equivalent elevation for water at — 6.85.	Observed pressure.	Pressure, in pounds.	Equivalent feet of depth.	Equivalent elevation for water at — 6.85.	Observed pressure.
	M. H. W.	Ground-water.			M. H. W.	Ground-water.	
1	2.31	9.06	Practically the same as computed for ground-water.	24	55.51	62.36	Practically the same as computed for ground-water.
2	4.63	11.48		25	57.82	64.67	
3	6.94	13.79		26	60.14	66.99	
4	9.25	16.10		27	62.45	69.30	
5	11.57	18.42		28	64.76	71.61	
6	13.88	20.73		29	67.08	73.93	
7	16.19	23.04		30	69.39	76.24	
8	18.50	25.35		31	71.70	78.55	
9	20.82	27.67		32	74.01	80.86	
10	23.13	29.98		33	76.33	83.18	
11	25.44	32.29		34	78.64	85.49	
12	27.76	34.61		35	80.95	87.80	
13	30.07	36.92		36	83.27	90.12	
14	32.38	39.23		37	85.58	92.43	
15	34.70	41.55		38	87.89	94.74	
16	37.01	43.86		39	90.20	97.05	
17	39.32	46.17		40	92.52	99.37	
18	41.63	48.48		41	94.83	101.68	
19	43.95	50.80		42	97.14	103.99	
20	46.26	53.11		43	99.46	106.31	
21	48.57	55.42		44	101.77	108.62	
22	50.89	57.74		45	104.08	110.93	
23	53.20	60.05		46	106.39	113.24	

NOTE.—Equivalent depth in feet = $\frac{34}{14.7} \times$ pressure.

These observations and computations were made by the speaker in connection with the caisson foundations for the Municipal Building, New York City.

Mr. Goodrich.

E. P. GOODRICH, M. AM. SOC. C. E. (by letter).—This paper is to be characterized by superlatives. Parts of it are believed to be exceptionally good, while other parts are considered equally dangerous. The author's experimental work is extremely interesting, and the writer believes the results obtained to be of great value; but the analytical work, both mathematical and logical, is emphatically questioned.

The writer believes that, in the design of permanent structures, consideration of arch action should not be included, at least, not until much more information has been obtained. He also believes that the design of temporary structures with this inclusion is actually dangerous in some instances, and takes the liberty of citing the following statement by the author, with regard to his first experiment:

"About an hour after the superimposed load had been removed, the writer jostled the box with his foot sufficiently to dislodge some of the exposed sand, when the arch at once collapsed and the bottom fell to the ground."

The writer emphatically questions the author's ideas as to "the thickness of key" which "should be allowed" over tunnels, believing that conditions within an earth mass, except in very rare instances, are such that true arch action will seldom take place to any definite extent, through any considerable depths. Furthermore, the author's reason for bisecting the angle between the vertical and the angle of repose of the material, when he undertakes to determine the thickness of key, is not obvious. This assumption is shown to be absurd when carried to either limit, for when the angle of repose equals zero, as is the case with water, this method would give a definite thickness of key, while there can be absolutely no arch action possible in such a case; and, when the angle of repose is 90°, as may be assumed in the case of rock, this method would give an infinite thickness of key, which is again seen to be absurd. It would seem as if altogether too many unknowable conditions had been assumed. In any case, no arch action can be brought into play until a certain amount of settlement has taken place so as to bring the particles into closer contact, and in such a way that the internal stresses are practically those only of compression, and the shearing stresses are within the limits possible for the material in question.

The author has repeatedly made assumptions which are not borne out by the application of his mathematical formulas to actual extreme conditions. This method of application to limiting conditions is concededly sometimes faulty; but the writer believes that no earth pressure theory, or one concerning arch action, can be considered as satisfactory which does not apply equally well to hydraulic pressure problems when the proper assumptions are made as to the factors for friction, cohesion, etc. For example, when the angle of repose is considered as zero, in the author's first formula for W_1, the value becomes $\frac{1}{2}$ W_1, whereas it

Mr. Goodrich.

should depend solely on the depth, which does not enter the formula, and not at all on the width of opening, l, which is thus included.

The author has given no experiments to prove his statement that "the arch thrust is greater in dryer sand," and the accuracy of the statement is questioned. Again, no reason is apparent for assuming the direction of the "rakers" in Fig. 3 as that of the angle of repose. The writer cannot see why that particular angle is repeatedly used, when almost any other would give results of a similar kind. The author has made no experiments which show any connection between the angle of repose, as he interprets it, and the lines of arch action which he assumes to exist.

With regard to the illustration of the condition which is thought to exist when the "material is composed of large bowling balls," supposedly all of the same size, the writer believes the conclusion to be erroneous, and that this can be readily seen by inspection of a diagram in which such balls are represented as forming a pile similar to the well-known "pile of shells" of the algebras, in the diagram of which a pile of three shells, resting on the base, has been omitted. It is then seen that unless the pressures at an angle of 60° with the horizontal are sufficient to produce frictional resistance of a very large amount, the balls will roll and instantly break the arch action suggested by the author. Consequently, an almost infinitesimal settlement of the "centering" may cause the complete destruction of an arch of earth.

The author's logic is believed to be entirely faulty in many cases because he repeatedly makes assumptions which are not in accordance with demonstrated fact, and finally sums up the results by the statement: "It is conceded" (line 2, p. 658, for example),* when the writer, for one, has not even conceded the accuracy of the assumptions. For instance, the author's well-known theory that pressures against retaining walls are a maximum at the top and decrease to zero at the bottom, is in absolute contradiction to the results of experiments conducted on a large scale by the writer on the new reinforced concrete retaining wall near the St. George Ferry, on Staten Island, New York City, which will soon be published, and in which the usual law of increase of lateral pressure with depth is believed to be demonstrated beyond question. It must be conceded that a considerable arch action (so-called) actually exists in many cases; but it should be equally conceded by the advocates of the existence of such action that changes in humidity, due to moving water, vibration, and appreciable viscosity, etc., will invariably destroy this action in time. In consequence, the author's reasoning in regard to the pressures against the faces of retaining walls is believed to be open to grave question as to accuracy of assumption, method, and conclusion.

---

* *Proceedings*, Am. Soc. C. E., for April, 1910.

Mr. Goodrich. The author is correct in so far as he assumes that "the character of the stresses due to the thrust of the material will" not "change if bracing should be substituted for the material in the area" designated by him, etc., provided he makes the further assumption that absolutely no motion, however infinitesimal, has taken place meantime; but, unless such motion has actually taken place, no arch action can have developed. An arch thrust can result only with true arch action, that is, with stable abutments, and the mass stressed wholly in compression, with corresponding shortening of the arch line. The arch thrust must be proportional to the elastic deformation (shortening) of the arch line. If any such arch as is shown in Fig. 5 is assumed to carry the whole of the weight of material above it, that assumed arch must relieve all the assumed arches below. Therefore each of the assumed arches can carry nothing more than its own mass. Otherwise the resulting thrust would increase with the depth, which is opposed to the author's theory.

Turning again to the condition that each arch can carry only its own weight: if these arches are assumed of thicknesses proportional to the distance upward from the bottom of the wall, they will be similar figures, and it is easily demonstrated that the thrust will then be uniform in amount throughout the whole height of the wall, except, perhaps, at the very top. This condition is contrary to the author's ideas and also to the facts as demonstrated by the writer's experiment on the 40-ft. retaining wall at St. George. Consequently, the author's statement: "nor can anyone * * * doubt that the top timbers are stressed more heavily than those at the bottom," is emphatically doubted and earnestly denied by the writer. Furthermore, "the assumption" made by the author as to "the tendency of the material to slide" so as to cause it "to wedge * * * between the face of the sheeting * * * and some plane between the sheeting and the plane of repose," is considered as absolutely unwarranted, and consequently the whole conclusion is believed to be unjustified. Nor is the author's assumption (line 5, p. 662),[*] that "the thrust * * * is measured by its weight divided by the tangent of the * * * angle of repose" at all obvious. Again (on the same page), the author designates as a "pressure" what he describes as "the weight of the mass, multiplied by the distance of its center of gravity vertically above the toe," while, in fact, such a product measures a "moment" and not a pressure. Finally, in the value given for P, in the last product, the factor, W, has been omitted in the text.

The author presents some very interesting photographs showing the natural surface slopes of various materials; but it is interesting to note that he describes these slopes as having been produced by the "continual slipping down of particles." The vast difference between angles of repose produced in this manner by the rolling friction of particles

---

[*] *Proceedings*, Am. Soc. C. E., for April, 1910.

Mr. Goodrich.

and the internal angles of friction, which must be used in all earth-pressure investigations, has been repeatedly called to the attention of engineers by the writer.*

The writer's experiments are entirely in accord with those of the author in which the latter claims to demonstrate that "earth and water pressures act independently of each other," and the writer is much delighted that his own experiments have been thus confirmed.

In Experiment No. 3, the query is naturally suggested: "What would have been the result if the nuts and washers had first been tightened and water then added?" Although the writer has not tried the experiment, he is rather inclined to the idea that the arch would have collapsed. With regard to Experiment No. 5, there is to be noted an interesting possibility of its application to the theoretical discussion of masonry dams, in which films of water are assumed to exist beneath the structure or in crevices or cracks of capillary dimensions. The writer has always considered the assumptions made by many designing engineers as unnecessarily conservative. In regard to the author's conclusions from Experiment No. 6, it should be noted that no friction can exist between particles of sand and surrounding water unless there is a tendency of the latter to move; and that water in motion does not exert pressures equal to those produced when in a static condition, the reduction being proportional to the velocity of flow.

The author's conclusion (p. 672),† that "pressure will cause the quicksand to set up hydraulic action," does not seem to have been demonstrated by his experiments, but to be only his theory. In this instance, the results of the writer's experiments are contrary to the author's theory and conclusion.

The writer will heartily add his protest to that of the author "against considering semi-aqueous masses, such as soupy sands, soft concrete, etc., as exerting hydrostatic pressure due to their weight in bulk, instead of to the specific gravity of the basic liquid." Again, similarly hearty concurrence is given to the author's statement:

> "If the solid material in any liquid is agitated, so that it is virtually in suspension, it cannot add to the pressure, and if allowed to subside it acts as a solid, independently of the water contained with it, although the water may change somewhat the properties of the material, by increasing or changing its cohesion, angle of repose, etc."

On the other hand, it is believed that the author's statement, as to "the tendency of marbles to arch," a few lines above the one last quoted, should be qualified, by the addition of the words, "only when a certain amount of deflection has taken place so as to bring the arch into action." Again, on the following page, a somewhat similar qualifica-

---

* "Lateral Earth Pressures and Related Phenomena," *Transactions*, Am. Soc. C. E., Vol. LIII, p. 272.

† *Proceedings*, Am. Soc. C. E., for April, 1910.

Mr. Goodrich. tion should be added to the sentence referring to the soft clay arch, that it would "stand if the rods supporting the intrados of the arch were keyed back to washers covering a sufficiently large area," by inserting the words, "unless creeping pressures (such as those encountered by the writer in his experiments) were exceeded."

The writer considers as very doubtful the formula for D_x, which is the same as that for W_1, already discussed. The author's statement that "additional back-fill will [under certain circumstances] lighten the load on the structure," is considered subject to modification by some such clause as the following, "the word 'lighten' here being understood to mean the reduction to some extent of what would be the total pressure due to the combined original and added back-fill, provided no arch action occurred."

The writer is in entire agreement with the author as to the probability that water is often "cut off absolutely from its source of pressure," with the attendant results described by the author (p. 679);* and again, that too little attention has been given to the bearing power of soil, with the author's accompanying criticism.

The writer cannot see, however, where the author's experiments demonstrate his statement "that pressure is transmitted laterally through ground, most probably along or nearly parallel to the angles of repose," or any of the conclusions drawn by him in the paragraph (p. 682),* which contains this questionable statement. Again the writer is at a loss as to how to interpret the statement that the author has found that "better resistance" has been offered by "small open caissons sunk to a depth of a few feet and cleaned out and filled with concrete" than by "spreading the foundation over four or five times the equivalent area." The writer agrees with the author in the majority of his statements as to the "bearing value and friction on piles," but believes that he is indulging in pure theory in some of his succeeding remarks, wherein he ascribes to arch action the results which he believes would be observed if "a long shaft be withdrawn vertically from moulding sand." These phenomena would be due rather to capillary action and the resulting cohesion.

Naturally, the writer doubts the author's conclusions as to the pressure at the top of large square caisson shafts when he states that "the pressure at the top * * * will * * * increase proportionately to the depth." Again, the author is apparently not conversant with experiments made by the Dock Department of New York City, concerning piles driven in the Hudson River silt, which showed that a single heavily loaded pile carried downward with it other unloaded piles, driven considerable distances away, showing that it was not the pile which lacked in resistance, as much as the surrounding earth.

---

* *Proceedings*, Am. Soc. C. E., for April, 1910.

Mr. Goodrich.

In conclusion, the writer heartily concurs with the statement that "too much has been taken for granted in connection with earth pressures and resistance," and he is sorry to be forced to add that he believes the author to be open to the criticism which he himself suggests, that "both in experimenting and observing, the engineer [and in this case the author] will frequently find what is being looked for or expected and will fail to see the obvious alternative."

Mr. Pruyn.

Francis L. Pruyn, M. Am. Soc. C. E. (by letter).—Mr. Meem should be congratulated, both in regard to the highly interesting theories which he advances on the subject of sand pressures—the pressures of subaqueous material—and on his interesting experiments in connection therewith.

The experiment in which the plunger on the hydraulic ram is immersed in sand and covered with water does not seem to be conclusive. By this experiment the author attempts to demonstrate that the pressure of the water transmitted through the sand is only about 40% as great as when the sand is not there. The travel of ground-water through the earth is at times very slow, and occasionally only at the rate of from 2 to 3 ft. per hour. In the writer's opinion, Mr. Meem's experiment did not cover sufficient time during which the pressure was maintained at any given point. It is quite probable that it may take 15 or 20 min. for the full pressure to be transmitted through the sand to the bottom of the plunger, and it is hoped, therefore, that he will make further experiments lasting long enough to demonstrate this point.

In regard to the question of skin friction on caissons and piles, it may be of interest to mention an experiment which the writer made during the sinking of the large caissons for the Williamsburg Bridge. These caissons were about 70 ft. long and 50 ft. wide. The river bottom was about 50 ft. below mean high water, and the caissons penetrated sand of good quality to a depth of from 90 to 100 ft. below that level. On two occasions calculations were made to determine the skin friction while the caissons were being settled. With the cutting edge from 20 to 30 ft. below the river bottom, the calculations showed that the skin friction was between 500 and 600 lb. per sq. ft. The writer agrees with Mr. Meem that, in the sinking of caissons, the arch action of sand is, in a great measure, destroyed by the compressed air which escapes under the cutting edge and percolates up through the material close to the sides of the caissons.

With reference to the skin friction on piles, the writer agrees with Mr. Meem that in certain classes of material this is almost a negligible quantity. The writer has jacked down 9-in. pipes in various parts of New York City, and by placing a recording gauge on the hydraulic jack, the skin friction on the pile could be obtained very accurately.

Mr. Pruyn. In several instances the gauge readings did not vary materially from the surface down to a penetration of 50 ft. In these instances the material inside the pipe was cleaned out to within 1 ft. of the bottom of the pile, so that the gauge reading indicated only the friction on the outside of the pipe plus the bearing value developed by its lower edge. For a 9-in. pipe, the skin friction on the pile plus the bearing area of the bottom of the pipe seems to be about 20 tons, irrespective of the depth. After the pipe had reached sufficient depth, it was concreted, and, after the concrete had set, the jack was again placed on it and gauge readings were taken. It was found that in ordinary sands the concreted steel pile would go down from 3 to 6 in., after which it would bring up to the full capacity of a 60-ton jack, showing, by gauge reading, a reaction of from 70 to 80 tons.

It is the writer's opinion that, in reasonably compact sands situated at a depth below the surface which will not allow of much lateral movement, a reaction of 100 tons per sq. ft. of area can be obtained without any difficulty whatever.

Mr. Carter. FRANK H. CARTER, ASSOC. M. AM. SOC. C. E. (by letter).—Mr. Meem has contributed much that is of value, particularly on water pressures in sand; just what result would be obtained if coarse crushed stone or similar material were substituted for sand in Experiment No. 6, is not obvious.

It has been the practice lately, among some engineers in Boston, as well as in New York City, to assume that water pressure on the underside of inverts is exerted on one-half the area only. The writer, however, has made it a practice first to lay a few inches of cracked stone on the bottom of wet excavations in order to keep the water from the concrete which is to be placed in the invert. In addition to the cracked stone under the inverts, shallow trenches dug laterally across the excavation to insure more perfect drainage, have been observed. Both these factors no doubt assist the free course of water in exerting pressure on the finished invert after the underdrains have been closed up on completion of the work. The writer, therefore, awaits with interest the repetition of Experiment No. 6, with water on the bottom of a piston buried in coarse gravel or cracked stone.

As for the arching effect of sand, the writer believes that Mr. Meem has demonstrated, on a small scale, an important principle. It must be regretted, however, that the box was not made larger, for, to the writer, it appears to be unsafe to draw such sweeping conclusions from small experiments. As small models of sailboats fail to develop completely laws for the design and control of large racing yachts, so experiments in small sand boxes may fail to demonstrate the laws governing actual pressures on full-sized structures.

Mr. Carter.

For some time the writer has been using a process of reasoning similar to that of the author for assumptions of earth pressure on the roofs of tunnel arches, except that the vertical forces assumed to hold up the weight of the earth have been ascribed to cohesion and friction, along what might be termed the sides of the "trench excavation."

The writer fails to find proof in this paper of the author's statement that earth pressures on the sides of a structure buried in the earth are greater at the top than at the bottom of a trench. That some banks are "top-heavy," is, no doubt, a fact, the writer having often heard similar expressions used by experienced trench foremen, but, in every case called to his attention, local circumstances have caused the top-heaviness, either undermining at the bottom of the trench, too much banked earth on top, or the earth excavated from the trench being too near the edge of the cut.

For some years the writer has been making extended observations on deep trenches, and, thus far, has failed to find evidence, except in aqueous material, of earth pressures which might be expected from the known natural slope of the material after exposure to the elements; and this latter feature may explain why sheeted trenches stand so much better than expected. If air had free access to the material, cohesion would be destroyed, and theoretical pressures would be more easily developed. With closely-sheeted trenches, the weather is practically excluded, and the bracing, which seemingly is far too small, holds up the trench with scarcely a mark of pressure. As an instance, in 1893, the writer was successfully digging sewer trenches from 10 to 14 ft. deep, through gravel, in the central part of Connecticut, without bracing; because of demands of the work in another part of the city, a length of several hundred feet of trench was left open for three days, resulting in the caving-in of the sides. The elements had destroyed the cohesion, and the sides of the trenches no longer stood vertically.

Recently, in the vicinity of Boston, trenches, 32 ft. wide, and from 25 to 35 ft. deep, with heavy buildings on one side, have been braced with 8 by 10-in. stringers, and bracers at 10-ft. centers longitudinally, and from 3 to 5 ft. apart vertically; this timbering apparently was too slight for pressures which, theoretically, might be expected from the natural slope of the material. Just what pressures develop on the sides of the structures in these deep trenches after pulling the top sheeting (the bottom sheeting being left in place) is, of course, a matter of conjecture. There can be no doubt that there is an arching of the material, as suggested by the author. How much this may be assisted by the practical non-disturbance of the virgin material is, of course, indeterminate. That substructures and retaining walls designed according to the Rankine or similar theories have an additional factor of safety from too generous an assumption in regard to earth pressure

Mr. Carter. is practically admitted everywhere. It is almost an engineering axiom that retaining walls generally fail because of insufficient foundation only.

For the foregoing reasons, and particularly from observations on the effect of earth pressures on wooden timbers used as bracing, the writer believes that, ordinarily, the theoretical earth pressures computed by Rankine and Coulomb, are not realized by one-half, and sometimes not even by one-third or one-quarter in trenches well underdrained, rapidly excavated and thoroughly braced.

Vol. XXXVI. AUGUST, 1910. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

REINFORCED CONCRETE PIER CONSTRUCTION.

Discussion.*

By WILLIAM ARTHUR PAYNE, M. AM. SOC. C. E.

WILLIAM ARTHUR PAYNE, M. AM. SOC. C. E. (by letter).—On the arrival of the first barge load of brick, to be used in building a residence on the estate to which this pier belongs, a severe northwest wind blew for two days, after the boat was moored alongside, directly against the head of the pier and the side of the boat. The effect on the pier was to crush the fender piles and cause a settlement of one of the caissons at the pier head on the west end. The caisson was knocked slightly out of alignment, and a settlement toward the west was observable. Mr. Payne.

The writer believes that this was caused by the pounding of the brick barge on the sand bottom on which the cassions rest, during half tide, the boat being raised from the bottom on a roller, and striking when the roller had passed. In order to protect the pier and avoid the bumping of barges against it, three groups of piles were driven about 8 ft. beyond the end, a secondary platform was built between these and the stringer of the pier, and arranged so that it would slide on the stringer in case of movement of the piles. This secondary platform is particularly advantageous in the handling of material, as the height of the dock was found to be excessive for passing up brick and cement. For handling material after it is deposited on the dock, an industrial railroad has been built. At the shore end of this railroad, brick and cement are dumped into wagons, in which they are carried up the hill to the house.

---

* This discussion (of the paper by Eugene Klapp, M. Am. Soc. C. E., printed in *Proceedings* for May, 1910, but not presented at any meeting) is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

MEMOIRS OF DECEASED MEMBERS.

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

LINUS WEED BROWN, M. Am. Soc. C. E.*

DIED MARCH 7TH, 1910.

In the death of Linus Weed Brown, which occurred in Monrovia, Cal., on March 7th, 1910, this Society lost one of its valued members and the Engineering Profession a most able exponent.

Mr. Brown was born in Burnside, Orange County, N. Y., in August, 1856, and received his early education in the schools of that town. He studied his profession in the Stevens Institute of Technology, Hoboken, N. J.

At the age of eighteen he entered the machine shops of the Pennsylvania Railroad, and later was employed as Draftsman by that Company, which position he held until 1880.

In 1880 he accepted a position with the Southern Pacific Railroad in New Orleans, La., and designed and supervised the construction of the Algiers shops.

In 1883 Mr. Brown severed his connection with the Southern Pacific Company and engaged in general engineering practice, principally in the line of sugar-house installations.

In 1885 he was elected Assistant City Engineer of New Orleans, which position he held for four years.

In 1890 he became Chief Engineer for the Caffrey Central Sugar Refinery, designing and supervising the erection of the buildings, which represented an expenditure of about $600 000. In the same year Mr. Brown was appointed Chief Engineer of the Franklin and Abbeville Railroad and built that road. At the same time he designed and built the Des Lignes sugar-house. In fact, he designed and built many of the large sugar mills and refineries erected in Louisiana about that time.

From 1892 to 1896 Mr. Brown held the office of City Engineer of New Orleans, and it was during this term that some of the most important works of his career were accomplished.

Under the direction of the City Council, and in consultation with B. M. Harrod, Past-President, Am. Soc. C. E., the late H. B. Richardson, M. Am. Soc. C. E., and Rudolph Hering, M. Am. Soc. C. E., Mr. Brown made a topographical survey of New Orleans, a study of precipitation and run-off, and prepared plans and specifications for a drainage system.

---

* Memoir prepared by Ole K. Olsen, Esq.

At the expiration of his term of office as City Engineer, he engaged in private practice, assuming charge, as Chief Engineer for the contractors, of the first construction work of the drainage system.

Prior to and during his term of office as City Engineer, Mr. Brown was Architect of the McDonogh School Fund in New Orleans, during which time he designed and built several new schools and remodeled a number of old buildings.

He was also Special Engineer for the New Orleans Levee Board on harbor and bank protection work. To the study of this work Mr. Brown devoted all his energies and knowledge for several years. At the same time he was a member of the New Orleans Advisory Board of Engineers on Sewerage and Water.

When the oil fields of Texas were first discovered, Mr. Brown's services were immediately engaged, and in the following years he devoted almost his entire time to the development of the oil fields and facilities for handling the oil. His operations were principally in the Beaumont and Sour Lake fields.

The holdings of the Southern Pacific Railroad Company in these regions demanded the services of an expert engineer, and Mr. Brown was engaged to take full charge of its interests.

In 1904 he was compelled to give up active business and seek the restoration of his health. To this end he spent some time in the Middle Western States and finally decided to go out to the Pacific Coast. The climate there proved so beneficial that he eventually settled in Bakersfield, Cal., where he accepted an appointment as Consulting Engineer for the Oil Department of the Southern Pacific Railroad and Chief Engineer of the Atlantic Division of the same line.

Shortly after he accepted this appointment the Colorado River broke through its banks and overflowed the valley known as the Salton Sea, across which the tracks of the Southern Pacific Road were laid. The Company was compelled to make a detour of approximately 100 miles around the inundated region.

The United States Government made several attempts to dam the break, but without success, and finally abandoned it. Then the Southern Pacific took up the matter, and, under Mr. Brown's direction, succeeded in closing the break with two massive dams, confining the river to its ordinary channel and preventing the increase of the Salton Sea.

While in California Mr. Brown invented an oil and sand separator, which the Southern Pacific Company is now using throughout its oil fields. He also invented a continuous water purifier and a special oil power-pump. All these machines are now on the market.

Mr. Brown was a man of sterling integrity; one who regarded his profession in the light of an obligatory public service. To this sense of duty he sacrificed much, primarily the necessary relaxation and rest from arduous labor, which undoubtedly accelerated the end of his useful and honorable career.

In recognition of the valuable services he rendered in connection with the levee protection work in New Orleans, Mr. Brown was made the recipient of public honors and testimonials of appreciation.

He is survived by a daughter and two sons; the latter are preparing to follow the engineering profession. His wife, who was Miss Joan Von Vesterfeldt of New York City, died in 1903.

Mr. Brown was elected a Member of the American Society of Civil Engineers on June 7th, 1899. He was also a Member of the Louisiana Engineering Society.

CHARLES ALFRED HASBROUCK, M. Am. Soc. C. E.*

Died February 1st, 1910.

Charles Alfred Hasbrouck was born at Forest Home, a suburb of Ithaca, N. Y., on July 31st, 1864. After studying in the schools at Ithaca, he entered Cornell University in 1880, from which, after completing a course in Civil Engineering, he was graduated in 1884, the youngest member of his class.

In July, 1884, Mr. Hasbrouck entered upon his professional career as Assistant Engineer of the Detroit Bridge and Iron Company, continuing with that firm until 1888. From August to November, 1888, he was employed with the King Bridge Company as Assistant Engineer.

In November, 1888, he was appointed Assistant Chief Engineer of the American Bridge Works, of Chicago, specializing in bridge and structural engineering.

In May, 1900, Mr. Hasbrouck was made Contracting Manager of the American Bridge Company, of New York, in charge of railroad structures on the Western Division, which position he held until his health failed. Thus, after 24 years of active service in his Profession, he was obliged to give up all work.

On June 14th, 1893, Mr. Hasbrouck was married to Miss Mary Fobes, of Cresco, Iowa, who died in 1907.

After retiring from business, Mr. Hasbrouck spent part of his time in El Paso, Tex., in search of health. In 1909, he went to Sierra Madre, and, later, to Pasadena, Cal., where he died on February 1st, 1910. He was a patient sufferer, never uttering a word of annoyance or fretfulness at his condition.

---

* Memoir prepared by Mr. Edward Capouch, Contracting Manager, American Bridge Company, Chicago, Ill.

At his expressed wish, he was buried from his boyhood home which he had always kept up, and which, with its beautiful grounds, he left to Cornell University.

Mr. Hasbrouck was elected an Associate Member of the American Society of Civil Engineers on February 3d, 1892, and a Member on December 5th, 1894. He was elected a Member of the Institution of Civil Engineers, of Great Britain, on February 2d, 1904.

JOHN HENDERSON SAMPLE. M. Am. Soc. C. E.*

Died March 4th, 1910.

John Henderson Sample, the only son of Judge William Sample, was born on April 3d, 1849, at Coshocton, Ohio. He entered Dennison University, Granville, Ohio, from which he was graduated in 1872. After leaving college, he was engaged on the early surveys of the Toledo and Ohio Central lines, working up from Axeman to Division Engineer.

Afterward Mr. Sample served as Chief Engineer of the Cincinnati, Lebanon, and Northern Railway, and Chief Engineer of the Cincinnati and Georgia (now the Southern Railway), from Rome to Macon, Ga., except from Austell to Atlanta. In 1883, he made surveys for the East Tennessee, Virginia and Georgia Railway (now the Southern Railway) in Alabama. He then became Chief Engineer of the Alabama Improvement Company, engaged in the location and construction of the Northern Alabama Railroad, and the development of coal and ore lands and the Town of Sheffield, Ala.

He was appointed Chief Engineer of the Toledo and Ann Arbor, on location and construction from Hammond Junction to Durand; Chief Engineer of location and construction of the Missouri Pacific lines in Kansas, Colorado, and Missouri; and from 1887 to 1889, he served as Chief Engineer on the construction of the Louisville, Henderson, and St. Louis Railway, from West Point to Henderson, Ky.

Mr. Sample made examinations and reports on timber and mineral lands in Kentucky, Tennessee, Virginia, and West Virginia, and in 1889, he examined and reported on the Mexican National Railroad, from Laredo, Tex., to the City of Mexico.

From 1889 to 1896, he was Chief Engineer of location and construction and General Superintendent of operation of the Pittsburg, Akron, and Western Railroad, from Delphos to Akron, Ohio. In 1897 he was appointed General Superintendent of the Cleveland, Akron, and Columbus Railroad, which position he held until this road was purchased by the Pennsylvania Company, in September, 1899. From that date to the time of his death, Mr. Sample was in the employ of the Pennsylvania Company, as Assistant Engineer, being engaged on line and grade revision and special work.

---

* Memoir prepared by W. B. Hanlon, Esq.

His father being a lawyer and Judge, he partook of his judicial nature, and all his lifework was based on the broad foundation of equity and honesty of purpose. He was a man of unobtrusive manner, retiring disposition, and unpretentious ways.

On June 7th, 1876, Mr. Sample was married to Miss Virginia Hughes. His wife died on June 24th, 1889.

Mr. Sample died suddenly in the Fort Pitt Hotel, at Pittsburg, Pa., on March 4th, 1910. He intended to leave for New York City during the day to bid farewell to his son, who was Assistant Engineer on the Madeira and Mamoré Railway, in Brazil, and had been spending his vacation of three months with his father.

To his children, and to those who knew him intimately, Mr. Sample leaves a memory of a life well rounded out by noble endeavor, and a fixedness of purpose to know and do the right. He was conscientious in every act and thought, a man of deep religious conviction, and though called suddenly from his earthly labors, he was ready for the higher service and duty.

Mr. Sample was elected a Member of the American Society of Civil Engineers on October 6th, 1886.

ALBERT MATHER SMITH, M. Am. Soc. C. E.*

Died February 27th, 1910.

Albert Mather Smith was born on October 5th, 1837, in New York City. He was the son of Charles Smith and Miss Alleta Loverich, and a direct descendant of Cotton Mather.

As a boy of fifteen he entered the Engineer Division of the Manhattan Gas Light Company, and later became Engineer of its West 18th Street Station. At the outbreak of the Civil War, Mr. Smith joined the 37th Regiment, New York Volunteers, organized by Colonel Roome, the President of the Manhattan Gas Light Company, and was chosen Captain of Company B. This Company was largely recruited from the force of the gas-works, and drilled in the office of the Gas Company at 4 Irving Place, New York City. Mr. Smith's regiment saw active service during the invasion of Pennsylvania, and also as special detail on the Chesapeake; and, later, during the Draft Riots in New York City.

---

* Memoir prepared by W. Cullen Morris, M. Am. Soc. C. E.

After the close of the War, Mr. Smith became Chief Engineer of the Manhattan Gas Light Company, and, later, when this Company was merged into the Consolidated Gas Company, he became Engineer of Distribution of the latter Company. At the time of his death he had been connected with the gas companies of New York City for 57 years.

On March 18th, 1863, Mr. Smith was married to Miss Anna Provoost Elwes, who died on January 14th, 1873. In 1878, Mr. Smith was married to his second wife, Miss Jane H. Bull. His widow, two sons, and a daughter survive him.

Mr. Smith was a Charter Member and Vice-President of the Society of Gas Lighting, the oldest existing gas association in the United States. He was elected a Member of the American Society of Civil Engineers on May 5th, 1886.

JACOBUS VAN DER HOEK, M. Am. Soc. C. E.*

Died December 22d, 1909.

Jacobus Van der Hoek, son of the late Gysbertus Van der Hoek and Johanna (Tupers) Van der Hoek, was born at Goes, The Netherlands, on March 19th, 1862. He received his early education at the Public Schools, and was graduated from the High School of his native town in August, 1879. In September of the same year he entered the Polytechnic School at Delft, The Netherlands, from which he was graduated, as Civil Engineer, in July, 1883.

During 1884 Mr. Van der Hoek was employed as Inspector on the construction of a dike across the "het slaak," a shallow tidewater 1½ miles wide, and made surveys and soundings for a record map of adjacent waters covering an area of 6 sq. miles.

In 1885 and 1886 he was employed by the Dutch Government as Assistant Engineer in charge of a party, to re-survey the principal rivers of Holland, and triangulated about 25 miles of river.

During 1887 Mr. Van der Hoek was Engineer in charge of the submarine shore protection for the "Polder of Schouwen," The Netherlands. In 1887 he left his native land for the United States, arriving in New York City, on December 25th.

From the latter part of 1888 to the beginning of 1890, he was employed by the Wheeling Bridge and Terminal Railway Company, at Wheeling, W. Va., under the late Job Abbott, M. Am. Soc. C. E., Chief Engineer. The work comprised steam railway construction, a bridge 2 000 ft. in length, including one span over the Ohio River, 525 ft. long, and three tunnels from 400 to 2 400 ft. long, all double-track and heavy work throughout. The Engineer who was in charge of the work, writes:

---

* Memoir prepared by F. E. Schall, D. C. Henny, H. F. Dunham and Paul S. King, Members, Am. Soc. C. E.

"Mr. Van der Hoek reported to me as Chief Draftsman and Office Assistant during the period above mentioned. He was so capable and earnest in all of his work, and so well qualified to perform it, that our relations were not only uniformly pleasant, but they marked the beginning of a friendship that lasted until the deplorable end of Mr. Van der Hoek's useful life."

In 1890, Mr. Van der Hoek entered the service of the Lehigh Valley Railroad and continued with this Company until July, 1909; during this time he was successively engaged as Chief Draftsman, Assistant, Resident, and Division Engineer. During the extension of the main line of the Lehigh Valley Railroad, from Sayre to Buffalo, he was employed as Chief Draftsman, designing masonry and other structures, also as Assistant and Resident Engineer in charge of certain sections of the line. Paul S. King, M. Am. Soc. C. E., the Chief Engineer in charge of the construction of this 175 miles of double-track railroad, soon recognized the exceptional engineering ability of Mr. Van der Hoek, and appointed him, successively, Assistant and Resident Engineer in charge of several sections; of his success and ability, Mr. King writes:

"The sad and sudden death of Mr. Van der Hoek was indeed a great shock to me and his many friends in the Lehigh Valley System, particularly in New York State, his field of professional work for so many years.

"I highly regarded his technical ability, sterling character, and untiring industry, both in the field and office. During the time he was engaged with me (nearly four years), he filled the positions of Chief Draftsman, Assistant, and Resident Engineer, and earned the respective promotions by the zeal and energy which was always characteristic of him with any work he had in hand. He continued throughout the period of construction, a record not equalled by any of the dozen or more Resident Engineers connected with that work. It was this observation of his conduct and activity in executing his work that warranted me to have confidence in his ability to take up the work to be done after the Operating Department took charge of the line, recommending him as the Engineer for Maintenance of Way of part of the new line."

In 1893, Mr. Van der Hoek was appointed Division Engineer of the Buffalo Division of the Lehigh Valley Railroad, and had charge, under the Superintendent of Maintenance of Way, of constructing stations, water stations, coal trestles, wharves, stone ballasting the line, building storage yards, rebuilding bridges, etc.; he continued in this position until July 1st, 1909.

One of his associates on the Lehigh Valley Railroad writes:

"I was intimately acquainted with Mr. Van der Hoek and his work from 1894 to the time of his death, and as a co-worker on the Lehigh

Valley Railroad it is a privilege to testify to his exceptional engineering ability, his strong, unflinching character, his untiring energy, and implicit adherence to the lines of duty. He had exceptional executive ability combined with a thorough knowledge of details. It was these qualities that made him so successful in his work.

"Mr. Van der Hoek was a sober, unassuming, and honest man, a generous and respected superior to his subordinates, a true friend, ever ready to assist an aspiring young man to greater knowledge and better positions; by these he will be truly missed and mourned."

On July 12th, 1909, Mr. Van der Hoek entered the service of the Lehigh Coal and Navigation Company, as Civil Engineer, under the General Superintendent of that company, at Lansford, Pa., to take charge of the railroad maintenance, water supply, land surveys, and new outside construction, on the extensive mining properties of that company in the anthracite coal fields.

Mr. Van der Hoek's exceptional ability was thoroughly recognized by his new employers, and his work and its results were fully appreciated; he had but laid his plans and perfected a proper organization when, on the afternoon of December 22d, 1909, while inspecting the work of laying a new water main through the Lansford, Pa., tunnel, he met his death by being run over by an engine, and his successful professional career was thus sadly ended. His Assistant, who had accompanied him on this inspection, met with the same lamentable fate.

On May 30th, 1896, Mr. Van der Hoek was married, in New York City, to Johanna Van der Bent, and is survived by his wife and two children.

He was elected a Member of the American Society of Civil Engineers on April 7th, 1897.

LUTHER ELMAN JOHNSON, Jun. Am. Soc. C. E.*

DIED MARCH 23D, 1910.

By the death of Luther Elman Johnson, the Engineering Profession has lost a bright and able young engineer whose career, though short, gave promise of a steady rise and a brilliant future.

Mr. Johnson, the son of Mr. and Mrs. M. D. Johnson, of Lawton, Okla., was born in Union, West Va., on August 10th, 1881. Most of his childhood and early manhood, however, were spent in Missouri. He received his High School training at Nevada, Mo., and his technical education at the Missouri State University, from which he was graduated in 1904, on his completion of the four years' course in Civil Engineering. In connection with the training at the University, Mr. Johnson, on graduation, was appointed and commissioned Brevet Second Lieutenant, in the National Guard of Missouri, by the Governor of the State.

---

* Memoir prepared by P. M. Fogg, Assoc. M. Am. Soc. C. E.

His professional work began shortly after graduation, with his employment in the United States Reclamation Service, in connection with investigations of reservoir sites for the storage of irrigation water in Oklahoma. Following this, Mr. Johnson was transferred to the Garden City, Kans., pumping project, where, from 1905 to 1907, he was engaged in concrete construction and other work. In the latter part of 1907, he was transferred to the Minidoka, Idaho, pumping project, where, as Assistant Engineer, he was engaged until shortly before his death.

His work on the latter project was in connection with the location and construction of canals, and he was in active charge of the building of a large number of small reinforced concrete and timber structures and bridges for the irrigation system. In prosecuting this work, Mr. Johnson showed ability of the first order, and gave evidence, by his conscientious, thorough, and careful work, of great promise for the future.

In March, 1910, his health failing, he returned to his home in Lawton, Okla., to recuperate from a general breakdown, but pneumonia set in, and he died on March 23d.

Mr. Johnson was a young man of sterling qualities and rugged honesty; his life was clean and strong, his character sweet and lovable, and his capabilities exceptional. Untiring devotion to and interest in his work were traits which had won for him the deepest respect of his associates and those who worked under his direction, and his death was a keen loss, not only to his family to whom he was a devoted son and brother, but to his many friends and to all those with whom his work brought him into contact.

Mr. Johnson was elected a Junior of the American Society of Civil Engineers on September 6th, 1904.

William P. Morse

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XXXVI—No. 7

PRESENTED TO
N.Y. CIVIL
ENGINEERING SOCIETY
BY
WILLIAM P. MORSE

AMERICAN
SOCIETY OF
CIVIL
ENGINEERS
FOUNDED
1852

September, 1910

Published at the House of the Society, 220 West Fifty-seventh Street, New York, the Fourth Wednesday of each Month, except June and July.

Copyrighted 1910, by the American Society of Civil Engineers.
Entered as Second-Class Matter at the New York City Post Office, December 15th, 1906.
Subscription, $8 per annum.

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XXXVI—No. 7

SEPTEMBER, 1910

Edited by the Secretary, under the direction of the Committee on Publications.

Reprints from this publication, which is copyrighted, may be made on condition that the full title of Paper, name of Author, page reference, and date of presentation to the Society, are given.

CONTENTS

Society Affairs..........................Pages 395 to 444.
Papers and Discussions................Pages 1207 to 1242.

NEW YORK 1910.

Entered according to Act of Congress, in the year 1910, by the AMERICAN SOCIETY OF CIVIL ENGINEERS, in the office of the Librarian of Congress, at Washington.

American Society of Civil Engineers

OFFICERS FOR 1910

President, JOHN A. BENSEL

Vice-Presidents

Term expires January, 1911:

GEORGE H. PEGRAM
EMIL SWENSSON

Term expires January, 1912:

JOHN T. FANNING
HUNTER McDONALD

Secretary, CHARLES WARREN HUNT

Treasurer, JOSEPH M. KNAP

Directors

Term expires January, 1911:

CHARLES L. HARRISON
GEORGE W. KITTREDGE
DEXTER BRACKETT
HORACE ANDREWS
GARDNER S. WILLIAMS
CHARLES S. CHURCHILL

Term expires January, 1912:

FRANCIS LEE STUART
SAMUEL C. THOMPSON
WILLIAM G. WILKINS
ARTHUR N. TALBOT
WILLIAM M. GARDNER
HORACE A. SUMNER

Term expires January, 1913:

WILLIAM E. BELKNAP
HORACE LOOMIS
GEORGE A. KIMBALL
PERCIVAL ROBERTS, JR.
CHARLES F. LOWETH
ARTHUR DEWINT FOOTE

Assistant Secretary, T. J. McMINN

Standing Committees

(THE PRESIDENT OF THE SOCIETY IS *ex-officio* MEMBER OF ALL COMMITTEES)

On Finance:

GEORGE H. PEGRAM
CHARLES S. CHURCHILL
GEORGE A. KIMBALL
HORACE LOOMIS
WILLIAM G. WILKINS

On Publications:

C. L. HARRISON
HORACE ANDREWS
WILLIAM E. BELKNAP
FRANCIS LEE STUART
EMIL SWENSSON

On Library:

GEORGE W. KITTREDGE
DEXTER BRACKETT
JOHN T. FANNING
HUNTER McDONALD
CHAS. WARREN HUNT

Special Committees

ON UNIFORM TESTS OF CEMENT: George S. Webster, Richard L. Humphrey, George F. Swain, Alfred Noble, Louis C. Sabin, S. B. Newberry, Clifford Richardson, W. B. W. Howe, F. H. Lewis.

ON CONCRETE AND REINFORCED CONCRETE: C. C. Schneider, J. E. Greiner, W. K. Hatt, Olaf Hoff, Richard L. Humphrey, Robert W. Lesley, Emil Swensson, A. N. Talbot, Joseph R. Worcester.

ON ENGINEERING EDUCATION: Desmond FitzGerald, Benjamin M. Harrod, Onward Bates, D. W. Mead, Charles Hansel.

ON STEEL COLUMNS AND STRUTS: Austin L. Bowman, Alfred P. Boller, Emil Gerber, Charles F. Loweth, Ralph Modjeski, Frank C. Osborn, George H. Pegram, Lewis D. Rights, George F. Swain, Emil Swensson, Joseph R. Worcester.

ON BITUMINOUS MATERIALS FOR ROAD CONSTRUCTION: W. W. Crosby, A. W. Dean, H. K. Bishop, A. H. Blanchard.

◆

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

HOUSE OF THE SOCIETY—220 WEST FIFTY-SEVENTH STREET, NEW YORK.

TELEPHONE NUMBER.................5913 Columbus.
CABLE ADDRESS.................."Ceas, New York."

Vol. XXXVI. SEPTEMBER, 1910. No. 7.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

SOCIETY AFFAIRS

CONTENTS

Minutes of Meetings: PAGE
Of the Society, September 7th, 1910 395
Of the Board of Direction, September 6th, 1910 399
Announcements:
Hours during which the Society House is open 400
Future Meetings 400
Searches in the Library 400
Papers and Discussions 401
Subscription Price to the Publications of the Society 401
Local Associations of Members of the American Society of Civil Engineers 402
Privileges of Engineering Societies Extended to Members 403
Accessions to the Library:
Donations 406
By purchase 407
Membership (Additions, Changes of Address, Resignations, Deaths) 409
Recent Engineering Articles of Interest 419

MINUTES OF MEETINGS

OF THE SOCIETY

September 7th, 1910.—The meeting was called to order at 8.30 P. M.; Vice-President George H. Pegram in the chair; Charles Warren Hunt, Secretary; and present, also, 67 members and 11 guests.

The minutes of the meetings of May 18th and June 1st, 1910, and of the Annual Convention, were approved as printed in *Proceedings* for August, 1910.

A paper by R. P. Black, Assoc. M. Am. Soc. C. E., entitled "Remedies for Landslides and Slips on the Kanawha and Michigan Railway," was presented by the Secretary.

The Secretary read a letter from the Assistant Secretary of the American Institute of Mining Engineers, announcing the coming meeting of the Institute at the Canal Zone from October 21st to November 15th, 1910, and extending an invitation to members of this Society to attend the meeting.

The Secretary announced the election of the following candidates by the Board of Direction on September 6th, 1910:

AS MEMBERS.

THOMAS ARCHIBALD BEDFORD, San Diego, Cal.
OLIVER CLARK BREED, Fulton, N. Y.
BYRON HARKNESS BRYANT, Chihuahua, Chih., Mexico.
LAWRENCE ALOYSIUS DOWNS, Chicago, Ill.
ROBERT FOSTER GADD, Hartford, Conn.
JAMES EDWIN GIBSON, Philadelphia, Pa.
FRED WOODBURN MCELROY, Lockport, N. Y.
PAUL MCLOUD, Binghamton, N. Y.
CHARLES MEADS, New York City.
ALFRED RAYMOND, New Orleans, La.
GEORGE FREDERICK SAMUEL, Chicago, Ill.
LEROY KEMPTON SHERMAN, Chicago, Ill.
SAMUEL TUPPER SMETTERS, Chicago, Ill.
CHARLES JAMES THORNTON, Hove, Sussex, England.

AS ASSOCIATE MEMBERS.

CHARLES WILLIAM BOWLES, London, England.
JOHN AUGUSTUS BRUCE, Omaha, Nebr.
GEORGE BUTLER, San Diego, Cal.
GEORGE WILKENSON CASE, West Lafayette, Ind.
CHARLES WILLIS CHASSAING, St. Joseph, Mo.
ROBERT COE, Philadelphia, Pa.
CHARLES BARROWS COX, Sunnyside, Wash.
WILLIAM NICHOLAS DAMBACH, Wheeling, W. Va.
OSWALD THORPE DUNN, Water Valley, Miss.
CLARENCE FREDERICK EBERLY, Washington, D. C.
HAROLD EDWARDS, Winnipeg, Man., Canada.
PAUL AUGUST HARTUNG, Greeley, Colo.
ANDREW JENKINS HAYES, Helena, Mont.
JOHN YOUNG JEWETT, Denver, Colo.
JONATHAN JONES, Pittsburg, Pa.
EDGAR ERNEST LARKINS, Omaha, Nebr.
EARL LOUIS MOSLEY, Grand Junction, Colo.
JOHN GEPHART MUNSON, Colgate, Md.
JOHN BONAVENTURE MURRAY, New York City.
GEORGE PAUL O'CONNELL, Brown Station, N. Y.
HERBERT DEWITT RAPALJE, Wilmington, N. C.
ALBERT HASKELL RHETT, New York City.
EZRA COLLIN SHOECRAFT, La Porte, Ind.
DONALD DAVID SMITH, Muskogee, Okla.
ROY MARTIN SNELL, Jocko, Mont.

Murray Sullivan, Salt Lake City, Utah.
Thomas Cary Tarver, Jr., Houston, Tex.
Edward Ballinger Taylor, Jr., Zanesville, Ohio.
David Crooker Trott, Manitowoc, Wis.
John Elliott Warner, Benton, Mo.
Robert Lee Whipple, Adams, Mass.

As Associates.

William Cooper Cuntz, New York City.
Charles Otto Gunther, Hoboken, N. J.

As Juniors.

Clifton George Bailey, Key West, Fla.
William Henry Baines, Jersey City, N. J.
Harry Bortin, Omaha, Nebr.
Wallace Laird Cadwallader, New York City.
John Waggoner Currey, Wagoner, Okla.
Torris Eide, New York City.
Chester Gordon Gillepsie, Oakland, Cal.
Guy Alexander Graham, Cold Spring, N. Y.
James Kidwell Grannis, Ft. Worth, Tex.
Charles Richard Irvin, Pittsburg, Pa.
William Morton Kinney, Pittsburg, Pa.
George Horace Mack, Aurora, Ill.
Donald Douglas Price, Lincoln, Nebr.
Ralph Mason Roberg, Kansas City, Mo.
Walter Sherman St. John, New York City.
George Henry Stadel, Stamford, Conn.
Kilborn Whitman, Jr., New York City.

The Secretary announced the transfer of the following candidates by the Board of Direction on September 6th, 1910:

From Associate Member to Member.

Frederic William Andros, Colombres, Tamaulipas, Mexico.
Louis Russell Ash, Kansas City, Mo.
John William Eber, Utica, N. Y.
Warrick Rigeley Edwards, Baltimore, Md.
Guert William Ensign, Harrisburg, Pa.
Frederick Elbert Field, Pittsburg, Pa.
John Peden Gardiner, Los Angeles, Cal.
John Thomas Garrett, St. Louis, Mo.
John Mifflin Hood, Jr., Baltimore, Md.
Lawrence Bates Jenckes, Worcester, Mass.
Burton Rutherford Leffler, Cleveland, Ohio.

CHARLES HENRY PRESTON, JR., Waterbury, Conn.
LOUIS HENRY SHOEMAKER, Pittsburg, Pa.
FRED J. WAGNER, Rome, N. Y.
THOMAS JEFFERSON WILKERSON, Pittsburg, Pa.
SAMUEL McCAIN YOUNG, New Orleans, La.

FROM JUNIOR TO ASSOCIATE MEMBER.

HECTOR ROBINS BURROUGHS, Brooklyn, N. Y.
CLAUDE EDWARD CHAPPELL, Benton Harbor, Mich.
TOSHITOMO CHIBA, Tokyo, Japan.
FRANCIS WINFIELD COLLINS, New York City.
ERNEST WILLARD CRAWLEY, New Haven, Conn.
WILLIAM SHEPPARD FITZRANDOLPH, Sloatsburg, N. Y.
FRED WILLIS HASELWOOD, Berkeley, Cal.
PAUL BERTRAM TALLMAN, Houston, Tex.
RALPH RUSSELL TINKHAM, Detroit, Mich.
WILLIAM FRANKLIN WHITAKER, Bakersfield, Cal.
LYLE ANTRIM WHITSIT, Massena, N. Y.

The Secretary announced the following deaths:

CHARLES EDWARD GOAD, elected Member, September 7th, 1881; died June 10th, 1910.

WILLIAM JACKSON, elected Member, September 3d, 1884; died June 30th, 1910.

WASHINGTON JONES, elected Member, October 7th, 1874; died July 30th, 1910.

JOHN JAY McVEAN, elected Member, September 3d, 1884; died August 21st, 1910.

HENRY HERMAN MARDEN, JR., elected Member, May 1st, 1901; date of death unknown.

SAMUEL McMATH ROWE, elected Member, September 2d, 1885; died May 22d, 1910.

ROGER BROOKE IRWIN, elected Associate Member, May 3d, 1910; died May 23d, 1910.

VARDRY ECHOLS McBEE, JR., elected Associate Member, October 7th, 1908; died June 20th, 1910.

CLINTON LEROY RICHARDSON, elected Junior, September 2d, 1902; Associate Member, October 2d, 1907; died July 7th, 1910.

RALPH CARROLL SOPER, elected Associate Member, August 31st, 1909; died June 16th, 1910.

NORMAN ALFRED TAYLOR, elected Junior, October 6th, 1903; Associate Member, December 5th, 1906; died August 29th, 1910.

JAMES ROOSEVELT SHANLEY, elected Associate, March 6th, 1907; died August 25th, 1910.

Adjourned.

OF THE BOARD OF DIRECTION

(Abstract)

September 6th, 1910.—President Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Churchill, Kimball, Stuart, Talbot, and Thompson.

Action was taken in regard to members in arrears for dues.

Ballots for membership were canvassed resulting in the election of 14 Members, 31 Associate Members, 2 Associates, and 17 Juniors, and the transfer of 11 Juniors to the grade of Associate Member.

Sixteen Associate Members were transferred to the grade of Member.

Applications were considered and other routine business transacted.

Adjourned.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

October 5th, 1910.—8.30 P. M.—At this meeting a paper entitled "The Tieton Canal," by E. G. Hopson, M. Am. Soc. C. E., will be presented for discussion.

This paper was printed in *Proceedings* for August, 1910.

October 19th, 1910.—8.30 P. M.—A paper by W. F. Strouse, M. Am. Soc. C. E., entitled "The Reconstruction of the Passenger Terminals at Washington, D. C.," will be presented for discussion.

This paper was printed in *Proceedings* for August, 1910.

November 2d, 1910.—8.30 P. M.—At this meeting a paper entitled "The Arch Principle in Engineering and Esthetic Aspects, and Its Application to Long Spans," by C. R. Grimm, M. Am. Soc. C. E., will be presented for discussion.

This paper is printed in this number of *Proceedings.*

November 16th, 1910.—8.30 P. M.—A paper by H. H. Wadsworth, M. Am. Soc. C. E., entitled "The Failure of the Yuba River Débris Barrier, and the Efforts Made for Its Maintenance," will be presented for discussion.

This paper is printed in this number of *Proceedings.*

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendix* to the Annual Report of the Board of Direction for the year ending December 31st, 1906, contains a summary of all searches made to that date.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussion of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings.* The issue of volumes of *Transactions* is dependent on the closing of discussions, and the co-operation of the membership in this matter is essential to the regular issue of each quarterly volume.

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussion, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

SUBSCRIPTION PRICE TO THE PUBLICATIONS OF THE SOCIETY

The following subscription rates have been fixed by the Board of Direction for the publications of the Society:

Proceedings, ten Numbers per annum, $8. Price for single numbers, $1.

Transactions, four Volumes per annum, $12. Price for single volumes, $4.

On the above prices there is a discount of 25% to members who desire extra copies of any of these publications, to Libraries, and to Book-dealers.

There is also an additional charge per annum, to cover foreign postage, of 75 cents for *Proceedings* and $1 for *Transactions,* or 8 cents and 25 cents, respectively, for single numbers.

---

* *Proceedings,* Vol. XXXIII, p. 20 (January, 1907).

A special subscription rate has been fixed by the Board for the *Proceedings* of the Society for the benefit of Students in Technical Schools. This rate is $4.50 per annum, and is available to any *bona fide* student of any technical school.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Friday of February, April, June, August, October, and November, and also on the third Wednesday of December, the latter being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., Assoc. M. Am. Soc. C. E., 623 Wells Fargo Building.

The by-laws of the Association provide for the extension of hospitality to any members of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest of the Association at any of the above meetings, if he will notify the Secretary that he is in San Francisco.

(Abstract of Minutes of Meetings)

April 22d, 1910.—The meeting was called to order; President Riffle in the chair; M. C. Couchot, M. Am. Soc. C. E., acting as Secretary; and present, also, 52 members and guests.

The Secretary read a report of the meeting of the Board of Directors of April 1st, 1910, at which the following business was transacted:

Relative to the matter of amalgamation with other local engineering societies, it was decided that such amalgamation would be detrimental to the interests of the Association, although special joint meetings might be arranged from time to time.

The Treasurer was instructed to purchase another 5% Western Pacific Railway bond.

It was decided to issue a circular letter urging upon the members the necessity for preserving their active interest in the Association.

The report was adopted unanimously.

A letter from A. M. Hunt, M. Am. Soc. C. E., was read by the Secretary, outlining the programme of the Convention of the American Institute of Electrical Engineers to be held from May 5th to 7th, and inviting the members of the Association to attend the meetings.

The Secretary read a letter from Otto von Geldern, M. Am. Soc. C. E., inviting the members to be present at a lecture, by Mr. Herman Schussler, on the present water supply of San Francisco.

President Riffle read a letter from George E. Gray, Hon. M. Am. Soc. C. E., now in his eighty-second year, expressing interest in the welfare of the Association, and regret at being unable to attend the meetings.

A paper by H. H. Wadsworth, M. Am. Soc. C. E., on "The Failure of the Yuba River Débris Barrier," was presented by the author, and discussed by many present.

Adjourned.

June 17th, 1910.—The meeting was called to order; President Riffle in the chair; E. T. Thurston, Jr., Secretary; and present, also, 36 members and guests.

The Secretary reported that the desirability of stimulating the discussion of Papers was considered at a meeting of the Board of Directors, and it was decided to call upon members individually from time to time for the discussion of papers in which it is thought they are particularly interested.

The Secretary announced that the Board of Directors had decided that the Association would bear all expense incidental to the illustration, by stereopticon, of any papers to be presented, including the preparation of the necessary lantern slides.

A paper by Morton L. Tower, M. Am. Soc. C. E., on "Results Obtained by the Coos Bay, Oregon, Jetty," was read by the author, in which he described and discussed the later observed results of the jetty construction forming the subject of a paper by William W. Harts, M. Am. Soc. C. E., published in *Transactions*, Am. Soc. C. E., Vol. XLVI. The subject was discussed briefly.

Adjourned.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

Architekten=Verein zu Berlin, Wilhelmstrasse 92, Berlin W. 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, 718 Caxton Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Colorado Association of Members, Am. Soc. C. E., H. J. Burt, Secy., 235 Equitable Building, Denver, Colo.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 803 Fulton Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur- und Architekten-Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur- und Architekten-Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE LIBRARY

(From August 2d to September 12th, 1910)

DONATIONS*

SEWERAGE.

The Designing, Construction, and Maintenance of Sewerage Systems. By A. Prescott Folwell, M. Am. Soc. C. E. Sixth Edition, Revised and Enlarged. Cloth, 9 x 6 in., illus., 10 + 506 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1910. $3.00.

In the preface to the first edition of this book, the author stated that it was his aim to produce a work on Sewerage which would embody the most recent data and ideas relating to the subject, and treat of both the Combined and Separate Systems in a comprehensive manner. No attempt was made to discuss at length the subject of Sewage Disposal. In the preface to this, the sixth, edition, it is stated that during the time since the first appearance of the book, few modifications of the ideas involved in Sewer Design and Construction have been developed, the most important being due to the increasing use of concrete. These modifications, the author states, he has endeavored to incorporate into this edition. The chapters dealing with the subject of Sewage Disposal have also been practically rewritten. Parts II and III, on the Construction and Maintenance of Sewers, are intended chiefly for those who may be called upon to superintend such work without previous experience, although it is hoped that they will aid those who are not novices. While primarily intended for practicing engineers, the subject-matter has been arranged, it is stated, as a textbook for engineering schools, Parts I and II having been so used by the author. The Contents are: Part I, Designing: The System; Amount of Sewage, Flow in Sewers; Flushing and Ventilation; Collecting the Data; The Design; Detail Plans; Specifications, Contract, Estimate of Costs. Part II, Construction: Preparing for Construction; Laying Out the Work; Oversight and Measurement of Work; Practical Sewer Construction. Part III, Maintenance: House Connections and Drainage; Sewer Maintenance. Part IV, Sewage Disposal; Disposal by Dilution; Methods of Treatment. Index.

Gifts have also been received from the following:

Alexandra (Newport and South Wales) Docks & Ry. Co. 1 pam.
Am. Electrochemical Soc. 1 vol.
Am. Inst. of Chemical Engrs. 1 bound vol.
Am. Inst. of Elec. Engrs. 2 bound vol.
Am. Inst. of Min. Engrs. 1 bound vol.
Am. Iron and Steel Assoc. 1 pam.
Australia-Commonwealth Bureau of Census and Statistics. 1 bound vol.
Baker Street & Waterloo Ry. Co. 1 pam.
Bangor, Me.-Water Board. 1 pam.
Berlin Kgl. Technische Hochschule. 1 pam.
Bibliotheek der Technische Hoogeschool te Delft. 2 vol., 2 pam.
Bilbao, Spain-Junta de Obras del Puerto. 1 bound vol.
Boston, Mass.-City Auditor. 1 bound vol.
Boston, Mass.-Statistics Dept. 5 pam., 1 bound vol.
Bradford, Pa.-City Clerk. 9 vol.
Cambrian Rys. Co. 1 pam.
Central London Ry. Co. 12 pam.
Charing Cross, Euston & Hampstead Ry. Co. 1 pam.
Charlotte, N. C.-City Engr. 2 pam.
Chemin de Fer Métropolitain de Paris. 1 pam.
Chicago, Ill.-Dept. of Health. 4 bound vol., 1 vol., 2 pam.
Cincinnati, Ohio-Water Dept. 1 pam.
Clarke, D. D. 1 bound vol.
Colorado-State Board of Health. 1 pam.
Colorado School of Mines. 7 pam.
Columbia Univ. 1 vol.
Conn.-State Highway Commr. 1 bound vol., 1 pam.
Conn. State Library. 3 bound vol., 2 vol.
Cornell Univ. Club. 1 bound vol.
Danzig Kgl. Technische Hochschule. 1 pam.
Denver & Rio Grande R. R. Co. 1 pam.
Depew, Chauncey M. 2 pam.
Egypt-Gen. Mgr. of State Rys. and Telegraphs. 1 pam.
El Paso, Tex.-City Engr. 1 pam.
Electric Railway Journal. 1 bound vol.
Eng. News Pub. Co. 32 bound vol., 20 vol., 239 pam., 1 map.
Florida-R. R. Comm. 1 pam.
Fort, E. J. 2 bound vol.
Furness Ry. Co. 1 pam.
Georgia-R. R. Comm. 4 pam.
Great Britain-Patent Office. 1 vol.
Great Central Ry. Co. 3 pam.
Great Northern & City Ry. Co. 1 pam.
Great Northern, Piccadilly & Brompton Ry. Co. 1 pam.
Great Northern Ry. Co. 1 pam.
Great Western Ry. Co. 1 pam.

---

* Unless otherwise specified, books in this list have been donated by the publishers.

Hannover Kgl. Technische Hochschule. 1 pam.
Harrisburg, Pa.-City Clerk. 6 vol., 6 pam.
Haverhill, Mass.-City Engr. 1 pam.
Hering, Rudolph. 1 vol.
Hull & Barnsley Ry. Co. 1 pam.
Illinois-Bureau of Labor Statistics. 1 bound vol.
Illinois-Canal Commrs. 1 pam.
Illinois-R. R. and Warehouse Comm. 2 pam.
Illinois-Secy. of State. 1 pam.
Illinois, Univ. of. 1 vol., 4 pam.
India-Public Works Dept. 12 pam.
Indiana-R. R. Comm. 3 pam.
Inst. of Marine Engrs. 1 bound vol.
Institution of Civ. Engrs. 2 bound vol.
Inter. Creosoting & Constr. Co. 1 pam.
Jackson, D. C. and W. B. 1 pam.
Kentucky-R. R. Comm. 3 bound vol.
Kyoto Imperial Univ. 8 pam.
Lehigh Valley Coal Co. 1 pam.
Lehigh Valley R. R. Co. 1 pam.
Leland Stanford Junior Univ. 3 pam.
Liverpool Overhead Ry. Co. 1 pam.
Locomotive Club. 1 pam.
London, England-Met. Water Board. 2 pam.
London, Brighton & South Coast Ry. Co. 1 pam.
London, Tilbury & Southend Ry. Co. 1 pam.
Louisiana-State Board of Health. 1 vol., 3 pam.
Maine, Univ. of. 2 vol.
Manchester, England-Rivers Dept. 1 vol.
Maryland-Mine Insp. for Allegany and Garrett Counties. 2 pam.
Maryport & Carlisle Ry. Co. 1 pam.
Mass.-State Forester. 2 pam.
Mass.-Tax Commr. 1 bound vol.
Mich.-State Dept. of Health. 2 bound vol.
Mich. Coll. of Mines. 3 pam.
Midland & South Western Junction Ry. Co. 1 pam.
Midland Ry. Co. 1 pam.
Milwaukee, Wis.-City Engr. 1 bound vol., 2 pam.
Municipal Engrs. of the City of New York. 1 bound vol.
National Elec. Light Assoc. 1 bound vol.
National Fire Protection Assoc. 3 pam.
New Orleans, La.-Sewerage and Water Board. 1 bound vol.
New York City-Municipal Civ. Service Comm. 1 bound vol.
New York State-Bureau of Town Highways. 9 pam.
New York State-Comptroller. 12 bound vol.
New York State-Dept. of Highways. 1 pam.
New York State-Public Service Comm., First Dist. 8 pam.
New York City Record. 2 bound vol.
North, Edward P. 1 bound vol.
North London Ry. Co. 1 pam.
North Staffordshire Ry. Co. 1 pam.
Nova Scotian Inst. of Sci. 1 pam.
Oberlin, Ohio-Water-Works Dept. 1 pam.
Ohio State Univ. 1 vol.
Parsons, William Barclay. 1 bound vol.
Permanent Inter. Assoc. of Road Congresses. 2 bound vol., 1 vol., 3 pam.
Pruyn, Francis L. 1 pam.
Randolph, Robert Isham. 1 pam.
Rhode Island-Board of Met. Park Commrs. 2 bound vol., 2 vol., 2 pam.
Rhode Island-Commr. of Forestry. 2 pam.
Rhode Island-State Board of Public Roads. 1 bound vol.
Rhymney Ry. Co. 1 pam.
Ross, Elmer W. 1 pam.
St. Louis, Mo.-Water Commr. 1 bound vol.
Sherrerd, Morris R. 2 pam.
Smithsonian Institution. 1 vol., 6 pam.
Soc. de l'Industrie Minérale. 1 vol.
Svenska Teknologföreningen. 1 pam.
Swain, George F. 1 pam.
Switzerland-Abteilung für Landeshydrographie. 4 pam.
Sydney Univ. Eng. Soc. 1 pam.
Taff Vale Ry. Co. 1 pam.
Tennessee-State Geol. Survey. 2 pam.
Transvaal-Min. Regulations Comm. 1 vol.
Tribus, Louis L. 1 pam.
Underwriters' Laboratories Inc. 1 pam.
U. S.-Bureau of Mines. 1 vol.
U. S.-Bureau of the Census. 2 bound vol., 8 pam.
U. S.-Dept. of Agriculture. 1 bound vol., 1 vol.
U. S.-Military Academy. 2 pam.
U. S.-Office of Exper. Stations. 1 pam.
U. S.-Patent Office. 1 vol.
U. S.-Secy. of War. 1 vol.
Victoria-Dept. of Mines. 1 map, 1 pam.
Victoria-Sludge Abatement Board. 1 pam.
Virginia-State Corporation Comm. 3 pam.
West Virginia-Geol. Survey. 1 pam.
Western Australia-Dept. of Mines. 1 pam.
Western Australia-Geol. Survey. 1 bound vol.
Wilson, W. Edward. 1 vol.
Wisconsin-Special Joint Committee on Highways. 1 pam.
Wulsch, A. 1 pam.
Wyoming-State Coal Mine Insp. 1 pam.

BY PURCHASE

Cours de Machines Marines. Deuxième Partie. Machines Alternatives Turbines Marines Moteurs à Combustion Interne. Par L. Jauch et A. Masméjean. J. Alté, Toulon, 1910.

The American Woods, Exhibited by Actual Specimens and With Copious Explanatory Text. By Romeyn B. Hough. Part XI, Representing Twenty-Five Species by Twenty-Five Sets of Sections. R. B. Hough, Lowville, 1910.

Canals and Traders, the Argument Pictorial as Applied to the Report of the Royal Commission on Canals and Waterways. By Edwin A. Pratt. P. S. King & Son, London, 1910.

Reports and Maps of the West Virginia Geological Survey. 6 Vol. The Acme Publishing Company, Morgantown, 1908–09.

The Foundations of Alternate Current Theory. By C. V. Drysdale. Edward Arnold, London, 1910.

Cement in Sea Water, Report on the Trials, Commenced in 1896, on the Recommendation of the Society of Scandinavian Portland Cement Manufacturers. By A. Paulsen. J. Jorgensen & Co., Copenhagen, 1909.

The Art of Aviation ; A Handbook Upon Aeroplanes and Their Engines, With Notes Upon Propellers. By Robert W. A. Brewer. McGraw-Hill Book Company, New York, 1910.

How to Build an Aeroplane. By Robert Petit. D. Van Nostrand Company, New York, 1910.

SUMMARY OF ACCESSIONS

(From August 2d to September 12th, 1910)

Donations (including 175 duplicates)	603
By purchase	14
Total	617

MEMBERSHIP

ADDITIONS

(August 1st to September 13th, 1910)

MEMBERS		Date of Membership.
Avery, Frederick Hague. 1457 Berwyn Ave., Chicago, Ill.		May 31, 1910
Eber, John William. Supt., N. Y. C. & H. R. R. R. Co., Utica, N. Y.	Assoc. M. M.	Sept. 4, 1907 Sept. 6, 1910
Edwards, Warrick Rigeley. Asst. Engr. of Bridges, B. & O. R. R., Baltimore, Md.	Assoc. M. M.	April 4, 1900 Sept. 6, 1910
Garrett, John Thomas. Pres., Missouri Bridge & Iron Co., 1000 Fullerton Bldg., St. Louis, Mo.	Assoc. M. M.	May 1, 1901 Sept. 6, 1910
Hood, John Mifflin, Jr. Chf. Engr., The United Rys. & Elec. Co., 1008 Continental Trust Bldg., Baltimore, Md.	Jun. Assoc. M. M.	May 31, 1904 June 6. 1906 Sept. 6, 1910
Leffler, Burton Rutherford. Engr. of Bridges, L. S. & M. S. Ry., Suite 3, The Chillon, Cleveland, Ohio	Assoc. M. M.	April 6, 1904 Sept. 6, 1910
McLoud, Paul. Div. Engr., State Dept. of Highways, Binghamton, N. Y.		Sept. 6, 1910
Meads, Charles. Pres., Charles Meads & Co., 299 Broadway, New York City		Sept. 6, 1910
Morrill, Asa Hall. 44 Tremlett St., Dorchester, Mass.		May 3, 1910
Preston, Charles Henry, Jr. Civ. and Cons. Engr., 136 Grand St., Waterbury, Conn.	Assoc. M. M.	Oct. 2, 1907 Sept. 6, 1910
Samuel, George Frederick. City Engr., Hyde Park Hotel, Chicago, Ill.		Sept. 6, 1910
Sherman, LeRoy Kempton. Asst. Engr., Sanitary Dist. of Chicago, 1500 American Trust Bldg., Chicago, Ill.		Sept. 6, 1910
Wagner, Fred J. Chf. Engr., Scott Bros., P. O. Box 403, Rome, N. Y.	Assoc. M. M.	April 4, 1906 Sept. 6, 1910
Wheeler, Bertrand Thorp. Engr. of Constr., N. Y., N. H. & H. R. R., 440 South Station, Boston, Mass.		June 30, 1910
Wilkerson, Thomas Jefferson. Asst. Engr.-Bridge Designer, Bureau of Constr., Dept. of Public Works, City Hall, Pittsburg, Pa.	Jun. Assoc. M. M.	April 3, 1894 Jan 5, 1898 Sept. 6. 1910
Wilson, William Edward. Secy., Am. Section, International Waterways Comm., 328 Federal Bldg., Buffalo, N. Y.	Jun. Assoc. M. M.	Jan. 6, 1903 June 7. 1905 June 30, 1910

ASSOCIATE MEMBERS		Date of Membership.
ANDRESS, HARRY R. 1604 South Grand Ave., St. Louis, Mo		May 31, 1910
BEBOUT, GUY BURNET. Junior Engr., U. S. Engr. Office, Wheeling, W. Va		June 30, 1910
BURROUGHS, HECTOR ROBINS. 570 Jefferson Ave., Brooklyn, N. Y	Jun. Assoc. M.	Mar. 3, 1908 Sept. 6, 1910
CALHOUN, DAVID ADAMS. Cons. Engr., 35 Nassau St., New York City	Jun. Assoc. M.	Oct. 6, 1908 May 31, 1910
CLEVELAND, HENRY BURDETT. Prin. Asst. Engr., New York State Dept. of Health, Albany, N. Y		May 31, 1910
DALY, DAVID AUGUSTUS. With Johnson Carey & Co., Railroad Contrs., Hockney Bldg., St. Paul, Minn		May 31, 1910
DICKERSON, JOHN THOMAS. Asst. Engr., Sales Dept., Scherzer Rolling Lift Bridge Co., 1616 Monadnock Bldg., Chicago, Ill		April 5, 1910
DUNN, OSWALD THORPE. Asst. Engr., Ill. Cent. R. R., Water Valley, Miss		Sept. 6, 1910
FITZRANDOLPH, WILLIAM SHEPPARD. Sloatsburg, N. Y	Jun. Assoc. M.	April 3, 1906 Sept. 6, 1910
HALL, WARREN ESTERLY. Asst. Engr., Porto Rico Irrig. Service, Juana Diaz, Porto Rico	Jun. Assoc. M.	Nov. 5, 1907 June 30, 1910
HAWLEY, CHARLES RAY. Princeton, W. Va	Jun. Assoc. M.	Feb. 5, 1907 April 5, 1910
HAYS, DAVID WALKER. Hydr. and Irrig. Engr., I. O. O. F. Bldg., Reno, Nev		May 31, 1910
JONES, JONATHAN. Structural Engr., McClintic-Marshall Constr. Co., Pittsburg, Pa		Sept. 6, 1910
MUNSON, JOHN GEPHART. Res. Engr. of Constr., on Baltimore Sewage Disposal Plant, for The New York Continental Jewell Filtration Co., Colgate, Baltimore, Md		Sept. 6, 1910
NICOL, WALTER HILLIARD. City Engr., Box 238, Tuscaloosa, Ala		June 30, 1910
O'HARA, JOSEPH MATTHEW. Engr. of Testing Laboratory, S. P. R. R. Co., 1109 Flood Bldg., San Francisco, Cal		June 30, 1910
SHOECRAFT, EZRA COLLIN. City Engr., La Porte, Ind		Sept. 6, 1910
SMOLEY, CONSTANTINE KENNETH. Prin. of School of Civ. Eng., International Correspondence Schools, Scranton, Pa		June 30, 1910
SPENCER, FRANK NORTON. Chf. Engr., The A. Bentley & Sons Co., 37 North Huron St., Toledo, Ohio		June 30, 1910
TAYLOR, EDWARD BALLINGER, JR. Div. Engr., Cincinnati & Muskingum Val. R. R. Co., Zanesville, Ohio		Sept. 6, 1910

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Tinkham, Ralph Russell. Designing Engr., Trussed Concrete Steel Co.; Address, 50 Hague Ave., Detroit, Mich	Jun. Assoc. M.	Oct. 3, 1905 Sept. 6, 1910

ASSOCIATES

Cuntz, William Cooper. Care, Goldschmidt Thermit Co., 90 West St., New York City	Sept. 6, 1910
Gunther, Charles Otto. Prof. of Math. and Head of Dept., Stevens Inst. of Technology, Hoboken, N. J.	Sept. 6, 1910

JUNIORS

Baines, William Henry. 569 Jersey Ave., Jersey City, N. J	Sept. 6, 1910
Bornefeld, Charles Fowler. Asst. Engr. for Galveston County, 2509 Broadway, Galveston, Tex	May 31, 1910
Cadwallader, Wallace Laird. Asst. Engr., Elec. Traction Dept., P. T. & T. R. R., 215 West 23d St., New York City	Sept. 6, 1910
Drager, Walter Louis. Westmont, Johnstown, Pa	May 3, 1910
Harrod, Tom Hind Hudson. Ithaca, Mich	Feb. 1, 1910
Irvin, Charles Richard. (Irvin & Witherow), 212 Keystone Bldg., Pittsburg, Pa	Sept. 6, 1910
Lyerly, Charles Abner, Jr. 501 Oak St., Chattanooga, Tenn	Feb. 1, 1910
McClure, Harry Clifford. 613 The Nasby, Toledo, Ohio.	Mar. 1, 1910
McMullen, Ray Webb. 149 Broadway, New York City	June 30, 1910
Manzanilla y Carbonell, José Justo. "H" y 13 (Vedado), Havana, Cuba	June 30, 1910
Mott, Thomas Clayton. High Falls, N. Y	May 3, 1910
Murphy, James Francis. Asst. Engr., Board of Water Supply of New York City, Brown Station, N. Y	May 31, 1910
O'Donnell, Charles Jerome. Asst. Engr., Board of Water Supply of New York City, R. F. D. No. 4, Newburgh, N. Y	April 5, 1910
Paul, Theodore Lochart. Care, Paradox Valley Irrig. & Land Co., Paradox, Colo	Feb. 1, 1910
Stadel, George Henry. Res. Engr. for C. W. Leavitt, Jr., 161 Sound View Ave., Stamford, Conn	Sept. 6, 1910
Stanton, Robert Brewster, Jr. 249 North 3d St., Hamilton, Ohio	Mar. 1, 1910
Strain, Benjamin. Asst. Engr., Cent. N. E. Ry. Co., Maybrook, N. Y	April 5, 1910
Strohl, Richards Merle. Genoa, Ottawa Co., Ohio	May 31, 1910
Tolles, Frank Clifton. Chf. of Party, Commrs. of Sewerage, 821 South 2d St., Louisville, Ky	May 31, 1910
Weber, Daniel Rishel. Care, Great Northern Ry. Co., Monroe, Wash	Mar. 1, 1910

CHANGES OF ADDRESS

MEMBERS

BEARDSLEY, JAMES WALLACE. Chf. Engr., Irrig. Service, Guayama, Porto Rico.

BENTZON, ADRIAN BENONI. Civ. Engr. and Contr., Calle Corcovado 408 Altos, Lima, Peru.

BLUNT, WILLIAM TITCOMB. 1147 Adams St., Dorchester, Mass.

BOYDEN, HARRY CHESTER. Asst. Engr., A., T. & S. F. Ry., Williams, Ariz.

BREWSTER, HENRY BAUM. Engr., H. S. Kerbaugh, Inc., Fairport, N. Y.

BROWN, WALTER HENRY. Care, Sierra & San Francisco Power Co., Sonora, Tuolumne Co., Cal.

BROWNELL, ERNEST HENRY. Civ. Engr., U. S. N., Navy Yard, Bremerton, Wash.

BURDEN, JAMES. Res. Engr., New York State Barge Canal, Barge Canal Office, Albany, N. Y.

CASE, JAMES FRANCIS. Vice-Pres., Cuban Eng. & Contr. Co., Apartado 669, Havana, Cuba.

CHENEY, HERBERT NEAL. Engr. of Constr., Boston Consolidated Gas Co., 24 West St., Boston, Mass.

CHESTER, JOHN NEEDELS. (Chester & Fleming), Union Bank Bldg., Pittsburg, Pa.

CONNOR, WILLIAM DURWARD. Maj., Corps of Engrs., U. S. A., Commanding First Battalion of Engrs., and Director of Civ. Eng., U. S. Engr. School, Washington Barracks, Washington, D. C.

DOUGLAS, BENJAMIN. Room 814, Ford Bldg., Detroit, Mich.

ELLIS, GEORGE EZRA. Signal Engr., Kansas City Terminal Ry. Co., 23d St. and Grand Ave., Kansas City, Mo.

FINLEY, EDWIN CLIFFORD. Pres. and Engr., Itawamba Eng. Co., Third National Bank Bldg., Room 1109, St. Louis, Mo.

FISH, JOHN CHARLES LOUNSBURY. Box 233, Stanford University, Cal.

FITCH, CHARLES HALL. 517 North 15th St., Boise, Idaho.

FOX, HENRY. Chf. Engr., Maryland Dredging & Contr. Co. and Furst Clark Dredging Co. (Res., 2305 Elsinore Ave.), Baltimore, Md.

GRUNSKY, CARL EWALD. Cons. Civ. Engr., 2714 Steiner St., San Francisco, Cal.

HARDING, JAMES JUDSON. General Delivery, Seattle, Wash.

HARING, JAMES SMITH. Asst. Engr. on Water Supply, City of Ithaca, Lock Box 412, Ithaca, N. Y.

HASLAM, ERWIN ERNEST. Civ. and Hydr. Engr., Pequea, Lancaster Co., Pa.

HERRMANN, FREDERICK CHARLES. Care, Spring Valley Water Co., Sunol, Cal.

HOBBY, ARTHUR STANLEY. Cons. Engr., "The Hedges," North Falmouth, Mass.

HOLT, ARTHUR GRANT. Div. Engr., C., M. & P. S. Ry., 258 Front Ave., Spokane, Wash.

MEMBERS (*Continued*)

HOWARD, CHARLES POPE. 426 Osborn Bldg., Cleveland, Ohio.

HOWARD, JOHN LEWIS. Asst. Engr., Metropolitan Park Comm.; Address, 58 Crescent Ave., Melrose, Mass.

HUGHES, JOHN WILBUR. 939 West 10th St., Erie, Pa.

HURRY, EDWARD HENRY. Hanover, Churt, Farnham, England.

JOHNSON, LUCIEN SAMUEL. U. S. Engr. Office, Frankfort, Ky.

KETCHUM, MILO SMITH. Dean, Coll. of Eng. and Prof. of Civ. Eng., Univ. of Colorado, Boulder, Colo.

KINNEAR, WILSON SHERMAN. Pres., Kansas City Terminal Ry. Co., 22d St. and Grand Ave., Kansas City, Mo.

KNIGHT, HERBERT MILLER. With The M. A. Talbott Co., Baltimore, Md.; Address, 205 West Garden St., Rome, N. Y.

LOCKWOOD, WILLARD DATUS. 23 Walnut Ave., Rockville Centre, N. Y.

McDONALD, WILLIAM NAYLOR. Gen. Contr., 781 East Bay St., Jacksonville, Fla.

MASON, FRANCIS. (Mason, Hilton & Co., Engrs. and Contrs.), 111 Broadway, New York City.

MATCHAM, CHARLES ARTHUR. 1727 Hamilton St., Allentown, Pa.

MOGENSEN, PETER. 1707 Eighth Ave., Spokane, Wash.

PEARL, WALTER. Care, Pioneer Constr. Co., Durango (Res., 630 Twenty-first St., Apartment 29, Denver), Colo.

POTTER, CHARLES LEWIS. Maj., Corps of Engrs., U. S. A., U. S. Engr. Office, 428 Custom House, St. Louis, Mo.

PUGH, DEWITT PAWLING. Asst. Engr., P. R. R., First National Bank Bldg., Monongahela City, Pa.

REED, PAUL LYON. Civ. Engr., U. S. N., Bureau of Yards and Docks, Navy Dept., Washington, D. C.

RIBLET, BYRON CHRISTIAN. Spokane Club, Spokane, Wash.

RIGHTER, ADDISON ALEXANDER. Director and Engr., John M. Ewen Co., 525 The Rookery, Chicago, Ill.

ROBINSON, WILLIAM HARPER. City Engr., City Hall, Manila, Philippine Islands.

SERBER, DAVID CHARLES. The Trudeau Sanitarium, Trudeau, Essex Co., N. Y.

SMITH, FRANCIS BETTS. In Chg. of Constr., Pearl Harbor Dry Dock for San Francisco Bridge Co., Care, Hawaiian Dredging Co., Ltd., Honolulu, Hawaii.

STEVENS, JOHN FRANK. Pres., Oregon Trunk Ry., 625 Railway Exchange, Portland, Ore.

STRICKLER, GRATZ BROWN. 1343 Girard St., N. W., Washington, D. C.

SUMNER, HORACE AUGUSTUS. Room 438 Century Bldg., Denver, Colo.

THORNLEY, JULIAN. The Ansonia, 73d St. and Broadway, New York City.

WADSWORTH, HENRY HAYES. U. S. Asst. Engr., 804 Chronicle Bldg., San Francisco, Cal.

WALLACE, HAROLD ULMER. Cons. Engr., Marquette Bldg., Chicago, Ill.

MEMBERS (*Continued*)

WEBB, WALTER LORING. Cons. Engr., 31 Runnymede Ave., Lansdowne, Pa.

WEEDIN, KIRBY CALHOUN. 117 East 6th St., Davenport, Iowa.

WEGMANN, EDWARD. Cons. Engr., Dept. of Water Supply, Gas and Electricity, 13 Park Row, Room 2520, New York City.

WILSON, CHARLES BEATTY. Supt., Foster-Creighton-Gould Co., 33d St. and River, Louisville, Ky.

WOOD, WARREN POWELL. Chf. Engr., Central Idaho Development Co., Ltd., Lewiston & Southeastern Elec. Ry. Co., Ltd., Salmon River Power Co., Ltd., Elec. Ry. Townsite Co., Nezperce & Idaho R. R. Co., and Idaho & Northwestern R. R. Co., Sumner, Wash.

WRIGHT, JOSEPH. Engr., U. S. Reclamation Service, Ronan, Mont.

ASSOCIATE MEMBERS

BARLOW, JOHN SADLER. Asst. Engr., O. & W. Ry., Rochester, Wash.

BASCOME, WESTERN RADFORD. Res. Engr., Manhattan Bridge, Brooklyn, N. Y. (Res., 140 Claremont Ave., New York City).

BASSETT, ROBERT JAY. 279 North Main St., Ansonia, Conn.

BILLINGSLEY, JAMES WARTELLE. Chronicle Bldg., Houston, Tex.

BLAAUW, GEERT. P. O. Box 182, Massena, N. Y.

BLAYLOCK, JOHN CHARLES. Designing Engr., Holabird & Roche, 5439 Southport Ave., Chicago, Ill.

BONNETT, CHARLES PIERRE. 241 West 101st St., New York City.

BURGOYNE, JOHN HENRY, JR. Engr., Amazon & Pacific Ry., Chimbote, Peru.

COCHRANE, VICTOR HUGO. (Hedrick & Cochrane) 1118 McGee St., Kansas City, Mo.

COREY, RAY HOWARD. Asst. Engr., Water Dept., City Hall, Portland, Ore.

DORSEY, LEANDER. Supt., United Eng. & Constr. Co., Sexton Bldg., Baltimore, Md.

ECKART, NELSON ANDREW. Res. Engr., Snow Mountain Water & Power Co., 3014 Clay St., San Francisco, Cal.

EDWARDS, OLIVER CROMWELL. Pres., The Pneumatic Caisson Co., 16 East 23d St., New York City (Res., 179 St. Marks Ave., Brooklyn, N. Y.).

FITCH, SQUIRE EARNEST. Falconer, N. Y.

FITZPATRICK, JAMES RAYMOND. Gen. Mgr., Grand Rapids Hydr. Co., 106 Michigan Trust Bldg., Grand Rapids, Mich.

FLEMING, THOMAS, JR. (Chester & Fleming), Union Bank Bldg., Pittsburg, Pa.

GARMAN, HARRY OTTO. Associate Prof. of Civ. Eng., Purdue Univ., 739 Owen St., Lafayette, Ind.

GARVER, NEAL BRYANT. Care, Coll. of Eng., Urbana, Ill.

GOODELL, JOHN STANTON. Amherst, Mass.

HALDEMAN, WALTER STANLEY. 510 Hall Bldg., Kansas City, Mo.

ASSOCIATE MEMBERS (*Continued*)

HAMILTON, FARRAR PETRIE. 662 North State St., Jackson, Miss.

HARRIS, HENRY ALEXANDER. 176 Nassau St., Princeton, N. J.

HAZELTON, WILLIAM SYLVESTER. 247 Hancock Ave., East, Detroit, Mich.

HECKLE, GEORGE ROGERS. Alberton, Md.

KING, ROY STEVENSON. Mech. Engr., 252 Jefferson St., Valparaiso, Ind.

KIRKPATRICK, HARLOW BARTON. 1734 Ridge Ave., Evanston, Ill.

KRELLWITZ, DIEDRICH WILLIAM. Bridge Designer, Public Service Comm., First Dist., 23 Flatbush Ave., Brooklyn, N. Y.

KYLE, GEORGE ALLEN. 625 Railway Exchange, Portland, Ore.

MACARTNEY, MORTON. City Engr., 01209 Hollis St., Spokane, Wash.

MCCLELLAND, CLAUDE LESLIE. Asst. Engr., New York State Barge Canal, 88 Railroad St., Cohoes, N. Y.

MCCORMICK, HERBERT GRANVILLE. U. S. Engr. Office, Louisa, Ky.

MATHESON, ERNEST GEORGE. 512 Manhattan Ave., New York City.

MERRIMAN, THADDEUS. Asst. to the Chf. Engr., Board of Water Supply, 165 Broadway, New York City.

MOSS, ROBERT FAULKNER. Care, Am. Trading Co., Yokohama, Japan.

MYERS, WILLIAM MADISON. Buena Vista, Va.

NIMMO, JAMES VALANCE. Care, Canadian Northern Pacific Ry., 18 Hastings St., W., Vancouver, B. C., Canada.

PACE, FULTON. Engr. for Central Aguirre, Central Aguirre, Porto Rico.

PARKER, CHARLES FREDERIC. Mine Operator, Care, Parker & Hamilton, Apartado 208, Durango, Dgo., Mexico.

PERKINS, ALBERT HENRY. Div. Engr., New York State Water Supply Comm., Albany, N. Y.

POWELL, THOMAS JETT. Surface Div., Engr. Dept., Dist. of Columbia (Res., 212 Thirteenth St., N. E.), Washington, D. C.

PROCTOR, LEWIS JEFFERSON. Care, The New York & Bermudez Co., Land Title Bldg., Philadelphia, Pa.

RIPLEY, BLAIR. Box 100, Kentville, Nova Scotia, Canada.

ST. HILL, FELIX PERCEVAL. Highbury, Longford, Tasmania.

SARGENT, ARTHUR WINTHROP. Junior Engr., U. S. Engr. Office, Seattle, Wash.

SCHARSCHMIDT, SAMUEL HOWARD. 1327 Mason St., Elkhart, Ind.

SEARS, WALTON HARVEY. Care, Lockwood, Greene & Co., 93 Federal St., Boston, Mass.

SESSER, JOHN CORNELIOUS. Care, G. N. Ry. Office, St. Paul, Minn.

SHEFFIELD, EDWARD NEWTON. Asst. Engr., N. Y., N. H. & H. R. R., Box 91, Short Beach, Conn.

SLOCUM, CURLYS LYON. Bridge Dept., Long Island R. R., Jamaica (Res., Lynbrook), N. Y.

SPIKER, WILLIAM CLARE. Forsyth Bldg., Atlanta, Ga.

STEVENS, PERLEY EGBERT. Asst. Engr., Bridge Dept., G. N. Ry., 1802 Hague Ave., St. Paul, Minn.

STONE, WILLARD WILBERFORCE. Asst. Engr., Board of Water Supply, City of New York, R. F. D. No. 4, Newburgh, N. Y.

ASSOCIATE MEMBERS (*Continued*)

Storer, Stacy Steward. Superv. Archt.'s Office, Treasury Dept., Washington, D. C.

Tebbetts, George Edward. Bridge Engr., Kansas City Terminal Ry., 23d St. and Grand Ave., Kansas City, Mo.

Wassner, Michael. 1257 Dearborn Ave., Chicago, Ill.

Whiting, George William Carlyle. Vice-Pres. and Gen. Mgr., The United Eng. & Constr. Co., Sexton Bldg., Baltimore, Md.

Whitted, Levi Romulus. Supt. of Constr., U. S. Public Bldgs., Treasury Dept., Burlington, N. C.

Wilhelm, Jerome Frederick. Care, Missouri Val. Bridge & Iron Co., Sacramento, Cal.

Wonson, Samuel Lamson. Bridge Dept., Mo. Pac. R. R., St. Louis, Mo.

Wyman, Alfred Marshall. Asst. Engr., Public Service Comm., First Dist., 154 Nassau St., New York City (Res., 24 Rutledge Ave., East Orange, N. J.).

ASSOCIATES

King, Wallace, Jr. Vice-Pres., United Bldg. Material Co., 30 Church St., Room 1012, New York City.

Lally, John Michael. 437 Spencer Pl., Bronx, New York City.

Pomeroy, Lewis Roberts. Chf. Engr., Ry. and Industrial Div., J. G. White & Co., Inc., 43 Exchange Pl., New York City.

Ray, David Heydorn. Instr., Physics and Mechanics, Coll. of the City of New York (Res., 329 Edgecomb Ave.), New York City.

Stroebe, George Gottlieb. Care, Bureau of Public Works, Manila, Philippine Islands.

Struckmann, Holgar. Chf. Engr. and Gen. Mgr., Iola Portland Cement Co., Iola, Kans.

Watson, Merrill. 12 North Arlington Ave., East Orange, N. J.

Wrenn, James Francis. Stillwater, N. Y.

JUNIORS

Atwood, Chester Ely. Caldwell, Idaho.

Barker, James Madison. With Am. Bridge Co., 20 Oxford St., Pittsfield, Mass.

Bennet, Orville Green, Jr. Care, The Okonite Co., 253 Broadway, New York City.

Bishop, Lyman Edgar. Box 35, Laramie, Wyo.

Brennan, Joseph Lawrence. 223 West 167th St., New York City.

Burpee, George William. Box 31, Station B, Worcester, Mass.

Calder, John Webster. 5520 Walnut St., Philadelphia, Pa.

Carpenter, J. C. Drainage Engr., U. S. Dept. of Agriculture, 201 N. Natchez Ave., North Yakima, Wash.

Chace, Amasa Manton. 10 Bay View Ave., Newport, R. I.

JUNIORS (*Continued*)

Cochran, Jerome. Designing Engr., Corrugated Bar Co., National Bank of Commerce Bldg., St. Louis, Mo.

Cunningham, John Earl. 2 Louisburg Sq., Boston, Mass.

Cunningham, John Wilbur. Draftsman, Bridge Dept., North Coast R. R. Co., 606 E. Indiana Ave., Spokane, Wash.

Field, Clesson Herbert. With Schuylkill Bridge Works, Philadelphia, Pa. (Res., 436 Torrey St., Brockton, Mass.).

Fisher, Wilbur Howard. 520 Sinto Ave., Spokane, Wash.

Germer, Wilhelm Eduard. Care, Mr. Jouett, 335 Madison Ave., Room 1222½ (Res., 8 West 64th St.), New York City.

Goodrich, Thomas MacLenathen. Archt. and Cons. Engr. (Goodrich & Goodrich), 329 Lumber Exchange Bldg., Portland, Ore.

Hanavan, William Lawrence. Asst. Engr., Board of Water Supply, New York City, R. F. D. No. 4, Newburgh, N. Y.

Hastings, Hudson Bridge. Care, Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill.

Henes, Harry William. Care, A. Bolter's Sons, 84 La Salle St., Room 612, Chicago, Ill.

Hirsch, John George. Asst. Engr. with D. W. Mead, 107 N. Hancock St., Madison, Wis.

Horton, John William. Asst. Engr., Central California Traction Co., 801 Twenty-fourth St., Sacramento, Cal.

Hughes, William Richard, Jr. 1003 South Ave., Wilkinsburg, Pa.

Jones, Benjamin Earl. Junior Highway Engr., U. S. Office of Public Roads, Helena, Mont.

Jones, Irving Paul. Care, Res. Engr., Mexican Ry., Mexico City, D. F., Mexico.

King, Arthur Caswell. Asst. Engr., Springfield Water-Works (Res., 43 Jefferson Ave.), Springfield, Mass.

Kingsley, George. Care, Const. Quartermaster, Sparta, Wis.

Lewis, Chester Brooks. Engr., Standard Constr. Co., 618 Rookery Bldg., Chicago, Ill.

McCandliss, Wallace Highland. Felton, Oriente, Cuba.

Mahone, William, Jr. Box 213, New Bern, N. C.

Moore, James Gates. Care, Piedmont Traction Co., Charlotte, N. C.

Moore, Stanley Wallace. 307 Kingsland Ave., Brooklyn, N. Y.

Nordwell, Alfred Worcester. 18 Lake Ave., Oakland, Cal.

Okes, Day Ira. 218 North 5th St., Minneapolis, Minn.

Porter, Harry Franklin. The Harris, 13th and Broadway, Kansas City, Mo.

Powell, William Jenner. 360 Allen St., Dallas, Tex.

Richards, Arthur. 530 South Webb Ave., Alliance, Ohio.

Russell, Alexander Allen MacVicar. 349 Frederick St., San Francisco, Cal.

Sanger, Walter Max. 370 Illinois St., Toledo, Ohio.

JUNIORS (*Continued*)

SCOTT, JOHN KUHN. 905 Heath St., Pittsburg, Pa.

STEINMAN, DAVID BERNARD. Instr. in Civ. Eng., Univ. of Idaho, Moscow, Idaho.

STEPHENSON, GRANT THOMAS. Gen. Supt., Mashek Chemical & Iron Co., Wells, Delta Co., Mich.

STEWART, CHARLES SUMNER. 1805 Warren Ave., Chicago, Ill.

STEWART, WALTER PHELPS. U. S. Junior Engr., 1307 Liggett Bldg., St. Louis, Mo.

STILES, ALBERT IRVINE. Asst. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama.

TODD, OLIVER JULIAN. Field Asst. to City Engr. of San Francisco; Address, Groveland, Cal.

TRASK, WARREN DUDLEY. Care, U. S. Reclamation Service, Ft. Shaw, Mont.

VEATCH, NATHAN THOMAS, JR. 1043 Indiana St., Lawrence, Kans.

WHITTEMORE, LESLIE CLIFFORD. Asst. Engr., Board of Water Supply of New York City, Box 752, Cornwall-on-Hudson, N. Y.

WILDER, ELLWOOD COGGESHALL. East Islip, N. Y.

WILEY, RALPH BENJAMIN. 123 Russell St., W. Lafayette, Ind.

WILMOT, JAMES. 16 Elgin St., Providence, R. I.

WILSON, WILLIAM WEST. Sherman Sq. Hotel, Broadway and 70th St., New York City.

YEO, WILLIAM ALBERT. 229 West 130th St., New York City.

RESIGNATIONS

JUNIORS	Date of Resignation.
SAUER, ALFRED FRANCIS	July 1, 1910

DEATHS

BIDDLE, WILLIAM FOSTER. Elected Member, June 4th, 1884; died August 10th, 1910.

JONES, WASHINGTON. Elected Member, October 7th, 1874; died July 30th, 1910.

McVEAN, JOHN JAY. Elected Member, September 3d, 1884; died August 21st, 1910.

SHANLEY, JAMES ROOSEVELT. Elected Associate, March 6th, 1907; died August 25th, 1910.

SOPER, RALPH CARROLL. Elected Associate Member, August 31st, 1909; died June 16th, 1910.

TAYLOR, NORMAN ALFRED. Elected Junior, October 6th, 1903; Associate Member, December 5th, 1906; died August 29th, 1910.

Total Membership of the Society, September 13th, 1910, 5 624.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(July 23d to September 12th, 1910)

NOTE.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal,* Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings,* Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions,* Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly,* Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator,* Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine,* New York City, 25c.
(10) *Cassier's Magazine,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News,* New York City, 15c.
(14) *Engineering Record,* New York City, 12c.
(15) *Railway Age Gazette,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway and Engineering Review,* Chicago, Ill., 10c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 10c.
(21) *Railway Engineer,* London, England, 25c.
(22) *Iron and Coal Trades Review,* London, England, 25c.
(23) *Bulletin,* American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal,* New York City, 10c.
(25) *American Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique,* Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France.
(34) *Portefeuille Economiques des Machines,* Paris, France.
(35) *Nouvelles Annales de la Construction,* Paris, France.
(37) *Revue de Mécanique,* Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways,* Paris, France.
(41) *Modern Machinery,* Chicago, Ill., 10c.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(44) *Journal,* Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals,* Scranton, Pa., 20c.
(46) *Scientific American,* New York City, 8c.
(47) *Mechanical Engineer,* Manchester, England.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(51) *Deutsche Bauzeitung,* Berlin, Germany.
(52) *Rigasche Industrie-Zeitung,* Riga, Russia.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions,* Am. Soc. C. E., New York City, $4.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.

(56) *Transactions*, Am. Inst. Min. Engrs., New York City, $5.
(57) *Colliery Guardian*, London, England.
(58) *Proceedings*, Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.
(59) *Transactions*, Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.
(60) *Municipal Engineering*, Indianapolis, Ind., 25c.
(61) *Proceedings*, Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *Industrial World*, 59 Ninth St., Pittsburg, Pa.
(63) *Minutes of Proceedings*, Inst. C. E., London, England.
(64) *Power*, New York City, 20c.
(65) *Official Proceedings*, New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Journal of Gas Lighting*, London, England, 15c.
(67) *Cement and Engineering News*, Chicago, Ill., 25c.
(68) *Mining Journal*, London, England.
(70) *Engineering Review*, New York City, 10c.
(71) *Journal*, Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs*, Iron and Steel Inst., London, England.
(73) *Electrician*, London, England, 18c.
(74) *Transactions*, Inst. of Min. and Metal., London, England.
(75) *Proceedings*, Inst. of Mech. Engrs., London, England.
(76) *Brick*, Chicago, Ill., 10c.
(77) *Journal*, Inst. Elec. Engrs., London, England.
(78) *Beton und Eisen*, Vienna, Austria.
(79) *Forscherarbeiten*, Vienna, Austria.
(80) *Tonindustrie Zeitung*, Berlin, Germany.
(81) *Zeitschrift für Architektur und Ingenieurwesen*, Wiesbaden, Germany.
(83) *Progressive Age*, New York City, 15c.
(84) *Le Ciment*, Paris, France.
(85) *Proceedings*, Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.
(86) *Engineering-Contracting*, Chicago, Ill., 10c.
(87) *Roadmaster and Foreman*, Chicago, Ill., 10c.
(88) *Bulletin* of the International Ry. Congress Assoc., Brussels, Belgium.
(89) *Proceedings*, Am. Soc. for Testing Materials, Philadelphia, Pa.
(90) *Transactions*, Inst. of Naval Archts., London, England.
(91) *Transactions*, Soc. Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin*, Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie*, Paris, France, 4 fr. 50.
(94) *The Boiler Maker*, New York City, 10c.
(95) *International Marine Engineering*, New York City, 20c.
(96) *Canadian Engineer*, Toronto, Ont., Canada, 15c.
(97) *Turbine*, Berlin, Germany, 1 Mark.
(98) *Journal*, Engrs. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.
(99) *Proceedings*, Am. Soc. of Municipal Improvements, New York City, $1.
(100) *Professional Memoirs*, Corps of Engrs., U. S. A., Washington, D. C., $1.
(101) *Metal Worker*, New York City, 10c.
(102) *Organ für die Fortschritte des Eisenbahnwesens*, Wiesbaden, Germany.
(103) *Mining and Scientific Press*, San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer*, London, England, 6d.
(105) *Metallurgical and Chemical Engineering*, New York City, 25c.

LIST OF ARTICLES.

Bridges.

The Design of Swing-Bridges.* James Athersmith Orrell, Stud. Inst. C. E. (63) Vol. 180.
Restoration of the Auld Brig O'Ayr.* (11) July 15.
The Erection of the Dumbarton Point Bridge.* (14) July 23.
Substructure of a Double-Track Railroad Bridge at Peoria.* (14) July 23.
The Mississippi River Bridge at St. Louis for the Illinois Electric Traction System.* (13) July 28.
Tests of Vanadium-Steel Eye-Bars.* (14) July 30.
The Eight-Track Bascule Bridge at Campbell Avenue, Chicago.* C. R. Dart and S. T. Smetters, Members W. S. C. (4) Aug.
Cost of Constructing Concrete Abutments for a Railway Bridge.* (86) Aug. 3.
A Tall Reinforced Concrete Bridge Pier.* (14) Aug. 6.
The Miles Glacier Bridge.* (14) Aug. 6.
Viaduct and Subway at Pocatello, Idaho.* (15) Aug. 12.
The Substructure of the Dumbarton Point Bridge.* (14) Aug. 13.
Erection of an Eight-Track Rolling Lift Bridge.* (14) Aug. 13.
Three-Hinged Reinforced-Concrete Arch Bridge, Los Angeles.* (14) Aug. 13.
Concrete Pedestal Abutments on the New York State Barge Canal.* (13) Aug. 18.

---

* Illustrated.

Bridges—(Continued).

A Plate Girder Arch Bridge Carrying a Concrete Roadway.* (14) Aug. 20.
Tests of Nickel Steel Riveted Joints; Details and Results of Tests Made for the Board of Engineers, Quebec Bridge.* (14) Aug. 20.
The Substructure of the American River Bridge.* (14) Aug. 27.
The Main Street Bridge over the Buffalo Belt Line.* (14) Aug. 27.
A New Form of Rail Connection for Drawbridges.* (13) Sept. 1.
Caissons for the Main Piers of the New Quebec Bridge.* (12) Sept. 2.
Typical Compression Members in Long Span Bridges.* Edgar Marburg, M. Am. Soc. C. E. (14) Sept. 3.
Bank Protection at the Missouri River Bridge, C. M. & P. S. Ry.* (18) Sept. 3.
Notes on the Construction of a Reinforced Concrete Arch Bridge with Some Costs.* W. A. Hoyt. (86) Sept. 7.
Caissons for the New Quebec Bridge; Launch of the North Pier Caisson.* (13) Sept. 8.
The Reconstruction of the Quebec Bridge.* (14) Sept. 10.
Pont de Sabarat sur l'Arize.* (84) Aug.
Pont en Béton Armé, à Trois Articulations, d'Amélie-les-Bains (Pyrénées-Orientales), et Applications du Même Système de Semi-Articulations.* Mesnager. (33) Aug. 27.
Umbau der Eisenbahnbrücke über die Lahn bei Oberlahnstein.* Heinrich Tecklenburg. (49) Pt. 7-9.
Neue ungarische Eisenbahn-Donaubrücken.* A. Pilder. (102) Serial beginning July 15.
Eiserner Ueberbau der Baumgartenbrücke bei Potsdam.* F. Eybächer. (48) Serial beginning July 23.
Erfahrungen und Beobachtungen beim Bau der 85 m weiten Wölbrücke über den Isonzo bei Salcano.* Leopold Orley. (53) Serial beginning Aug. 19.
Fundierung der Rüstringer Brücke bei Wilhelmshaven.* Röhlke. (78) Sept. 2.

Electrical.

The Arrangement of Experimental Electrical Circuits for Laboratories.* W. P. Steinthal. (77) June.
Losses off Transmission Lines due to Brush Discharge with Special Reference to the Case of Direct Current. E. A. Watson. (77) June.
Modern Electric Time Service.* F. Hope-Jones. (77) June.
Balancers for Three-Wire Systems.* A. G. Cooper. (77) June.
Some Notes on Standardisation of Electrical Machines. R. Orsettich. (77) June.
The Physical Properties of Switch and Transformer Oils.* W. Pollard Digby and D. B. Mellis. (77) June.
Rating and Test of Motors for Intermittent Working. Robert Pohl. (77) June.
Graphical Treatment of the Zigzag and Shot Leakage in Induction Motors.* R. E. Hellmund. (77) June.
Street Illumination.* James R. Cravath. (Paper read before the Engrs'. Soc. of Milwaukee.) (1) July.
Practical Notes on Illumination by Cooper-Hewitt Mercury Lamps.* L. Crouch. (26) Serial beginning July 15.
Poles and Pole Lines. F. L. Rhodes. (Paper read before the N. E. Telephone Soc.) (96) July 21.
Installation of Large Battery and Boosters at Dickinson Street Electricity Works, Manchester.* S. L. Pearce. (26) July 22.
Isolated Industrial Generating Installation.* Albert L. Clough. (27) July 28.
The Testing of Transformer Regulation.* C. V. Drysdale. (73) July 29.
Recent Arrangements for the Parallel Running of Electric Machines.* W. Wolf. (Abstract from *Elektrotechnik und Maschinenbau.*) (73) July 29.
Short-Circuiting of Large Electric Generators and the Resulting Forces on Armature Windings.* Miles Walker. (77) Aug.
The Design of Turbo Field Magnets for Alternate-Current Generators with Special Reference to Large Units at High Speeds.* Miles Walker. (77) Aug.
Hydro-Electric Installations of Sweden.* Aubrey V. Clayton. (77) Aug.
Commutation Phenomena and Magnetic Oscillations Occurring in Direct-Current Machines.* G. W. Worrall. (77) Aug.
Diversity Factor.* H. B. Gear. (42) Aug.
Combination Electric Light, Water and Ice Plant.* (27) Aug. 4.
Foundations for Electrical Machinery.* Bruce Page. (27) Aug. 4.
Cost of Electricity.* W. D. Marks. (27) Aug. 4.
American Switchboard Practice.* Stephen Q. Hayes. (27) Serial beginning Aug. 4.
Electricity for Factories at Kokomo, Ind.* (27) Aug. 4.
Paralleling Alternators.* (12) Serial beginning Aug. 5.
Electric Plant at Messina, Italy.* (27) Aug. 11.
Hydroelectric Generating Station at Trollhättan, Sweden.* (27) Aug. 11.

---

* Illustrated.

Electrical—(Continued).

Polyphase Commutator Machines.* J. Jonas. (Abstract from *Elek. Zeit.*) (73) Aug. 12.
Three Phase Versus Single Phase Transformers.* Gordon Kribs. (96) Aug. 18.
Moving 370 Feet of Conduit Intact.* (27) Aug. 18.
New Post Office Telephone Exchange, Glasgow.* (26) Serial beginning Aug. 26.
Tungsten Lamps.* G. S. Merrill. (42) Sept.
A Modern Combination Utility Plant.* (27) Sept. 1.
Gas and Oil-Burning Electric Power Station.* (27) Sept. 1.
Recent Patents in Wireless Telegraphy.* W. H. Eccles. (7) Serial beginning Sept. 2.
The Dielectric Properties of Modern High-Tension Cables.* M. Höchstädter. (Abstract from *Elektrotech. Zeit.*) (73) Sept. 2.
Single-Phase Commutator Motor.* Shiro Sano. (27) Sept. 8.
Les Radioconducteurs et leurs Applications à la Télégraphie et à la Télédynamique sans Fils.* E. Branly (92) July.
L'Horlogerie Electrique.* M. Béache. (33) Serial beginning Aug. 6.
Drehstromkollektormotoren mit regelbarer Umlaufzahl. A. Matthias. (48) Aug. 20.
Versuche über den Einfluss des elektrischen Stromes auf Beton.* W. Gehler. (78) Serial beginning Sept. 2.

Marine.

The Otago Graving Dock, Port Chalmers, New Zealand. Robert Hay, M. Inst. C. E. (63) Vol. 180.
The Fruhling Suction Dredge.* John Ried. (2) July.
The *Jan Breydel* and *Pieter de Coninck* on the Ostend-Dover Service.* (11) July 15; (33) Aug. 6.
Screw Propeller Dimensions.* (12) July 29.
The Vulcan Company's New Yard at Hamburg.* (11) Serial beginning July 29.
A Proposed Method for Raising the *Maine* from Havana Harbor.* (13) Aug. 4.
The Possibilities of the Hydroplane.* (11) Aug. 5.
The Electrical Equipment of Smith's Docks, Middlesbrough.* (26) Aug. 5.
The Electrical Propulsion of French Submarines.* J. Breguet. (73) Aug. 26.
Stability Models and Tables.* Arthur R. Liddell. (12) Aug. 26.
A New Departure in American Shipbuilding.* (95) Sept.
On the Powering of Ships.* Sidney Graves Koon. (95) Sept.
A New Lake Passenger Steamer.* (95) Sept.
Comparative Trials of the Scout Cruisers *Birmingham, Salem* and *Chester*. (13) Sept. 1; (95) Aug.
L'Evolution dans les Systèmes de Constructions Navales; un Nouveau Système de Construction.* G. Hart. (32) May.
Das Schiffshebewerk mit Balanciers- und Gegengewichten.* Fr. Jebens. (81) Pt. 5.
Vergleichsversuche mit Schiffschrauben.* A. Pröll. (48) July 16.
Boot- und Schiffsmaschinen für flüssigen Brennstoff auf der Internationalen Motorboot- und Motoren-Ausstellung, Berlin 1910.* A. Heller. (48) Sept. 3.

Mechanical.

The Portland-Cement Industry of the United States and Canada. Arthur Charles Davis, Assoc. Inst. C. E. (63) Vol. 180.
Recent Developments in Wheel Testing at Purdue University.* Charles H. Benjamin. (Paper read before the Engrs.' Club of St. Louis.) (1) June.
Small Steam Turbines.* John Gurney Callan. (Paper read before the Boston Soc. Civ. Engrs.) (1) June.
Street Illumination.* James R. Cravath. (Paper read before the Engrs.' Soc. of Milwaukee.) (1) July.
American Producer Gas Practice. A. J. McCarte. (8) Serial beginning July.
Semet-Solvay Coke Ovens and By-Products Recovery Plant at Dean and Chapter Colliery.* (57) July 15.
Coke for Foundry Purposes. E. L. Rhead. (Paper read before the Brit. Foundrymen's Assoc.) (11) July 15.
Further Studies in Coal Carbonization. R. Forbes Carpenter. (66) July 19.
High-Speed Steam-Turbine Rotor Design and Construction.* John McKenzie Newton. (Paper read before the Jun. Inst. of Engrs.) (47) Serial beginning July 22.
Clearing House for Goods in London.* (73) July 22.
Gas Producers.* J. Hofmann. (Abstract of paper read before the Inter. Cong. at Düsseldorf.) (22) July 22; (20) Aug. 4.
Firebricks for By-Product Coke Ovens.* (22) July 22.
The Works of Messrs. Alfred Herbert, Limited, Coventry.* (11) July 22.
A Coal and Ash Handling Plant (with Underground Transportation System).* (13) July 28.

---

* Illustrated.

Mechanical—(Continued).

Ash Handling System in the Allis-Chalmers Power Plant.* C. A. Tupper. (14) July 30.
The Precooling Plants of the Pacific Fruit Express Company.* (14) July 30.
The Selection, Use and Abuse of Steam Boilers. Byron Cummings. (Abstract of paper read before the Mfrs. Assoc., York, Pa.) (94) Aug.
The Balancing of Reciprocating Engines.* R. J. Grimshaw. (10) Aug.
Clay Digging on the Hudson.* (76) Aug.
Costs of Machine-Tool Operations in Steam-Engine Manufacturing. Wm. O. Webber. (9) Aug.
The Transmission of Power by Manila Ropes.* William B. Hosford. (41) Aug.
The Manufacture of French Aeroplanes.* Warren H. Miller. (3) Aug.
Some Problems in Clay Winning.* W. D. Richardson. (76) Aug.
A Pumping Engine Taking Steam at Atmospheric Pressure.* (13) Aug. 4.
The Exploitation of our Peat Bogs. Eugene Haanel. (Paper read before the Amer. Peat Assoc.) (96) Aug. 4.
Grinding Machinery and the Manufacture of Grinding Wheels.* John H. Davey. (Paper read before the Glasgow Tech. College.) (47) Aug. 5.
The Tendencies of Modern Coking Practice. Ernest Bury. (57) Aug. 5.
The Eiffel Aero-Dynamometric Installation.* (12) Aug. 5.
Belt Conveyors for Handling Crushed Stone.* (14) Aug. 6.
The New Smoke Law, Boston.* Howard S. Knowlton. (14) Aug. 6.
Modern Methods of Brick Making.* Alfred B. Searle. (29) Serial beginning Aug. 12.
Plant of the Ogden Portland Cement Company.* (14) Aug. 13.
The Bergen Hill Stone Crushing Plant, Erie Railroad.* (14) Aug. 13.
The Cost of Steam Power in a Mill Plant. Howard S. Knowlton. (14) Aug. 13.
Tests of Two 5 000 000-Gal. Horizontal Pumping Engines at the Canarsie Pumping Plant, Brooklyn, N. Y. (13) Aug. 18.
The Cambria Steel Works.* (15) Aug. 19.
Mechanical Cargo Handling.* (14) Aug. 20.
An Anchor for Airships.* (From *Umschau.*) (19) Aug. 20.
Modern Methods in a Coal Tipple.* Henry Harrison. (16) Aug. 20.
Rapid Sand Unloader at Panama.* (62) Aug. 22.
High-Pressure Gas for Railway Purposes.* (66) Aug. 23.
Thermit Practice in America in Welding, Casting and Metallurgy.* Ernest Stutz. (13) Aug. 25.
Line Shaft Drive and Individual Motor Drive in Machine Shops. A. G. Popcke. (47) Aug. 26.
Coal and Ash Handling Plant for a Large Building.* (14) Aug. 27.
Furnace Draft in its Relation to Smoke Prevention.* Sylvester S. Howell. (Paper read before the Inter. Assoc. for the Prevention of Smoke.) (62) Aug. 29.
New Power Station at Scranton, Penn.* F. W. Brady. (64) Aug. 30.
High-Pressure Gas for Textile Mills. Charles Walton. (Abstract of paper read before the Textile Soc. of Manchester School of Tech.) (66) Aug. 30.
French Aeroplane Motors.* Warren H. Miller. (9) Sept.
The Fuel Requirements of the Rotary Cement Kiln. W. S. Landis. (105) Sept.
Test of a 15 000-KW. Steam-Engine-Turbine Unit.* H. G. Stott and R. J. S. Pigott. (42) Sept.
Gearing for Machine Tools.* Thomas R. Shaw. (10) Sept.
Testing Discharge of a Turbo Blower.* (22) Sept. 2.
Aerial Propellers and Some Test Results.* Charles Edward Larard, M. I. Mech. E., and Robert Oliphant Boswall. (11) Sept. 2.
The Rolling of Iron and Steel. Oscar C. Morgan. (Abstract of paper read before the Nottingham Guild of Mech. and Elec. Engrs.) (47) Sept. 2.
Notes on Drilling Holes in Concrete. J. R. Taft, M. Am. Soc. C. E. (14) Sept. 3.
Hauling with Traction Engines on the Los Angeles Aqueduct.* (14) Sept. 3.
Concrete Mixing Plant for Roadbed Repairs. (14) Sept. 3.
Mechanical Features of a Power Plant at Landy, France.* Warren H. Miller. (14) Sept. 3.
A New Steel Belt Conveyor in Use in Sweden.* Alfred Gradenwitz. (16) Sept. 3.
Condensers for Small Central Stations.* Harry Pennington. (Paper read before the Southwestern Elec. and Gas Assoc.) (24) Sept. 5.
Freight Unloading System at Manaos, Brazil.* Charles J. Seibert. (13) Sept. 8.
The Equipment of the Cement Mill of the Portland Cement Company of Utah.* Leroy A. Palmer. (13) Sept. 8.
Operating and Maintenance Costs of Locomotive Coal and Ash Handling Stations. Henry J. Edsall. (13) Sept. 8.
Comparison of Gyratory and Jaw Crushers.* H. L. Wollenberg. (16) Sept. 10.
The Manufacture of Carbonate of Ammonia from Gas House and Coke Oven Plant Liquor. R. W. Hilgenstock. (24) Sept. 12.
Un Nouveau Mode de Fonctionnement Economique des Foyers de Générateurs à Vapeur et Autres Réalisé par le "Tirage Equilibre."* Serge Heryngfet. (32) May.

---

* Illustrated.

Mechanical—(Continued).

L'Acétylène et ses Applications.* P. Rosemberg. (92) June.

Essais sur la Determination de la Dépense d'Energie des Laminoirs.* J. Puppe. (Paper read before the Verein deutscher Eisenhüttenleute.) (93) July.

Etude sur les Cables Transporteurs Aériens.* Thiery et Cretin. (37) Serial beginning July 31.

Un Nouveau Procédé de Métallisation.* Schoop. (93) Aug.

Voie Sèche ou Voie Humide? Lors de l'Emploi des Fours Rotatifs. (84) Serial beginning Aug.

Four à Tremper Vertical des Forges de Douai (Etablissements Arbel).* Le Ct. Fourgeot. (93) Aug.

Mesure des Quantités de Gaz au Moyen de Diaphragmes.* Otto Muller. (93) Aug.

Commande Electrique de Laminoirs à Toles, Tôleries de Louvroil (Nord).* A. Mauduit. (33) Aug. 27.

Le Laboratoire Aéronautique de Chalais-Meudon et les Expériences sur les Hélices Propulsives.* G. Espitallier. (33) Aug. 27.

Die Kohlenkipper der neuen Hafenteile in Duisburg-Ruhrort.* Ottmann und Loebell. (49) Serial beginning Pt. 7-9.

Kohlenverladebühnen in Mannheim.* F. Zimmerman. (102) Serial beginning July 15.

Ueber die Fortschritte in der Gewinnung der Nebenprodukte beim Kokereibetriebe. O. Rau. (50) Serial beginning July 20.

Der gegenwärtige Stand der Gliederkesselindustrie.* Pradel. (48) July 23.

Berechnung und Wärmeausstrahlung steinerner Winderhitzer.* Chr. Aldendorff. (50) July 27.

Ueber das Verhalten von Kraftmaschinen im mechanischen oder elektrischen Parallelbetrieb.* Otto Ohnesorge. (48) July 30.

Der Genauigkeitsgrad der Federmanometer.* G. Klein. (48) July 30.

Zum heutigen Stande des basischen Windfrischverfahrens in Deutschland.* Esser. (50) Aug. 3.

Der Kraftmaschinenbau auf der Weltausstellung in Brüssel 1910. (48) Serial beginning Aug. 6.

Die Hebezeuge und Förderanlagen auf der Weltausstellung in Brüssel, 1910.* Aumund. (48) Serial beginning Aug. 13.

Versuche an einer mit Zwischenüberhitzung durch Frischdampf arbeitenden Heissdampf-Verbundmaschine.* M. F. Gutermuth und Watzinger. (48) Aug. 13.

Ueber den heutigen Stand der Gichtgasreinigung in Deutschland.* Curt Grosse. (50) Serial beginning Aug. 17.

Die massgebenden Konstanten bei der Regelung der Kraftmaschinen und ihre Wechselbeziehungen.* Kröner. (97) Aug. 20.

Die Berechnung rotierender Trommeln.* Rudolf Lorenz. (48) Aug. 20.

Ueber die neuere Entwicklung der Kokerei nach Bauart der Ofen und Ausbildung des mechanischen Betriebes.* Fr. Herbst. (50) Serial beginning Aug. 31.

Die Bodengewinnung bei grossen Erdarbeiten. H. Contag. (48) Serial beginning Sept. 3.

Metallurgical.

Notes on Roasting and Sintering; with Particular Reference to the Dwight & Lloyd Process. F. M. Smith. (Paper read before the Montana Soc. of Engrs.) (1) July.

Smelting Works of Teziutlan Copper Company.* A. Van Zwaluwenburg. (16) July 23.

Agglomeration of Manganiferous Limonite Ore. F. Witte. (16) July 30.

The Strength of the Alloys of Electrolytic Iron and Monel Metal.* Charles F. Burgess and James Aston. (105) Aug.

The Yampa Smelter at Bingham.* Leroy A. Palmer. (45) Aug.

Circular Copper Blast Furnaces.* Thomas E. Lambert. (45) Aug.

The Mechanical Charging of Blast Furnaces.* Edgar J. W. Richards and Thomas Lewis. (Paper read before the Cleveland Inst. of Engrs.) (22) Aug. 5.

Theory of the Dissolution of Metals by Cyanide. J. B. Stuart. (103) Aug. 6.

Basic Lined Converters for Leady Copper Mattes. Redick R. Moore. (16) Aug. 6.

Electric Smelting of Iron Ore at Heroult, Cal.* John Tyssowski. (16) Aug. 6.

Fume Filtration for Production of Pure Spelter.* John S. G. Primrose. (16) Aug. 27.

Cyanidation of Concentrate. F. C. Brown. (103) Aug. 27.

Trail Smelter and Lead Refinery.* J. M. Turnbull. (45) Sept.

Recent Practice in Copper Matte Converting. Redick R. Moore. (16) Sept. 3.

Settling Fine Dust at Copper Queen Smeltery.* George B. Lee. (16) Sept. 10.

The Greenawalt Electrolytic Copper Process.* William E. Greenawalt. (62) Sept. 12.

Traitement Thermiques des Aciers Spéciaux. L. Guillet. (Paper read before the Congress of Metallurgy at Düsseldorf.) (93) July.

---

* Illustrated.

Metallurgical—(Continued).

Quelques Observations Théoriques et Pratiques sur la Cimentation. L. Guillet. (Paper read before the Congress of Metallurgy at Düsseldorf.) (93) July.
Traitements Thermiques des Produits Cimentés.* L. Guillet. (Paper read before the Congress of Metallurgy at Düsseldorf.) (93) July.
Untersuchungen von Gusseisen-Emails. Julius Grünwald. (50) July 13.
Der Elektrostahlofen System Nathusius.* B. Neumann. (50) Aug. 17.

Mining.

Power Production at Collieries, with Special Reference to Gas Power and Electrical Centralization.* Robert Crawford and Harold Moores. (59) Vol. 32.
The Possibilities of Rescue Work in Connexion with Mine Explosions and Fires.* J. S. Haldane. (59) Vol. 32.
The Sinking and Equipping of Penallta Colliery.* George G. Hann. (From *Trans.* South Wales Inst. of Engrs.) (57) Serial beginning July 15; (22) July 22.
A Concrete Lined Shaft in Loose Ground. (14) July 23.
Surface Equipment at Clonan Shaft, Mineville, N. Y.* Guy C. Stoltz. (16) July 23.
Continuous Agitation System at Esperanza.* M. H. Kuryla. (16) July 30.
A Model Coal Mining Plant in Wyoming.* Henry M. Payne. (16) July 30.
Hydraulic Mining of Auriferous Gravels.* James W. Phillips, M. W. S. E. (4) Aug.
Miami Concentrating Mill.* R. L. Herrick. (45) Aug.
Power for Concentrating Mill. F. C. Bowman. (45) Aug.
The Cascade Motor.* Williams-Ellis. (Paper read before the Assoc. of Min. Elec. Engrs.) (22) Aug. 5.
Tailing Dams and Conservation of Mill Water.* (16) Aug. 6.
Concentration of Slime. Edwin A. Sperry. (103) Serial beginning Aug. 6.
The Kentish Ragstone Quarries. P. Walton Harrison. (Paper read before the Inst. Mun. Engrs.) (104) Aug. 12.
Reconstruction of the Angustias Cyanide Mill.* Herbert A. Megraw. (16) Aug. 13.
Design of a Mine Plant.* J. W. Whitehurst and W. P. Cary. (103) Serial beginning Aug. 13.
Mining and Smelting Plant of Mond Nickel Co.* Grant B. Shipley. (16) Aug. 20.
Slime Treatment at the Santa Natalia Mill.* Cooper Shapeley. (16) Aug. 20.
Kibble Hooks.* (From *Zeit. für Berg-, Hutten-und Salinenwesen.*) (57) Aug. 26.
Electrical Equipment of the Rose Bridge and Douglas Bank Collieries, Wigan.* W. Winsborough. (73) Aug. 26.
Underground Winding Plant of the New Modderfontein G. M. Co. R. H. Copeland. (Abstract of paper read before the South African Inst. Elec. Engrs.) (73) Aug. 26.
Cyaniding at the North Star Mines in Califorina.* John Tyssowski. (16) Aug. 27.
Refuge Chambers in Coal Mines.* George S. Rice. (Paper read before the West Virginia Coal Min. Inst.) (16) Aug. 27.
The Wind Rock Coal Mine.* W. S. Hutchinson. (45) Sept.
Working a Steep Coal Seam.* Austin Y. Hoy. (45) Sept.
The Effect on the Solubility of Gold when Ore is Crushed between Iron Surfaces. J. M. Tippett. (105) Sept.
Los Pilares Mine.* Edward M. Robb, Jr. (45) Sept.
The Superior and Boston Mine.* R. L. Herrick. (45) Sept.
Relative Advantages of Electric and Steam Winding on the Rand. Edwin J. McWilliams. (Abstract from *South African Min. Jour.*) (22) Sept. 2.
The Ohio Concentrator.* Leroy A. Palmer. (103) Sept. 3.
Details of Mine Surveying. A. E. Robinson. (103) Sept. 3.
Emploi des Chambres de Sureté dans les Mines.* Ch. Marquet. (32) May.
Ueber Bewegung und Lagerung von Eisenerzen auf Grubenanlagen.* K. Glinz. (50) Serial beginning Aug. 31.

Miscellaneous.

The Recent Advances in Pyrometry.* Robert S. Whipple. (Paper read before the Birmingham Metallurgical Soc.) (11) July 22; (73) July 22; (47) Aug. 5.
Depreciation Estimates on United States Reclamation Works. (14) July 23.
Hydraulic Stripping.* Paul Beer. (76) Aug.
A Cave-In Caused by an Underground Stream at Staunton, Va.* F. B. Van Horn. (13) Sept. 1.
L'Outillage Technique et Pratique du Dessinateur.* Jean Escard. (37) Serial beginning July 31.

---

* Illustrated.

Municipal.

San Joaquin County Highway Improvements. (14) July 23.

Highways of Pennsylvania, their Improvement. Joseph W. Hunter. (98) Aug.

Experimental Work in 1909 of the U. S. Office of Public Roads in Dust Prevention and Road Preservation. (86) Aug. 3.

Petrolithic and other Systems of Road and Street Improvements at El Paso, Tex. (13) Aug. 4.

Modern Methods of Street Cleaning. George A. Soper, M. Am. Soc. C. E. (Abstract of paper read before the New England Conference on Street Cleaning.) (13) July 28; (86) Aug. 10.

Some Costs of Street Paving Work at Baltimore, Md. (86) Aug. 10.

The Physical and Chemical Characteristics of Bituminous Road Materials. Prevost Hubbard. (Paper read before the Inter. Road Congress.) (86) Aug. 17.

Methods of Laying Out Cities.* Charles W. Barnaby. (10) Sept.

Final Conclusion Adopted by the Second International Road Congress, at Brussels. (13) Sept. 1.

Street Cleaning and Watering in 20 Great Towns of the United Kingdom. T. H. Yabbicom, M. Inst. C. E. (Abstract of paper read before the Inter. Road Cong.) (13) Sept. 1; (86) Sept. 7.

Les Travaux de Construction de Tunnel sous l'Elbe à Hambourg.* L. Descans. (30) Aug.

Railroads.

Straight Run-Outs of Cant at the Ends of Circular Curves on Railways.* Fulwar Craven Fowle, M. Inst. C. E. (63) Vol. 180.

Railway-Signalling in India.* Charles William Hodson, M. Inst. C. E. (63) Vol. 180.

The Design of Rolling Stock for Smooth-Rail Working on Heavy Gradients.* Frederick William Bach, M. Inst. C. E. (63) Vol. 180.

Electric Traction (Austria and Hungary); Subject for Discussion at the Eighth Session of the Railway Congress.* Arthur Hruschka. (88) June.

Steam Locomotives for Very High Speeds; Subject for Discussion at the Eighth Session of the Railway Congress.* Courtin. (88) June.

The Use of Steel, Special Steels; Subject for Discussion at the Eighth Session of the Railway Congress. Ernest Szlabey. (88) June.

An Automatic Signal for Electric Railways.* Carl P. Nachod. (2) July.

Consolidation Type Locomotive for the South Manchuria Railway. (12) July 15.

The Eastleigh Locomotive Works of the London and South-Western Railway Company.* (12) Serial beginning July 15.

Note on the Graphical Determination of Moments of Inertia.* C. E. P. Sankey. (12) July 15.

British Methods of Operating Single Tracks.* (90) July 21.

Locomotive for the Soudan Government Railways.* (12) July 22.

Elimination of the Susquehanna Crossing, Lackawanna Railroad.* (14) July 23.

Methods and Cost of Steam Shovel Work, Loading Slag, Earth and Sand Into Cars for Railway Ballasting and Grading. D. A. Wallace. (86) July 27.

Methods and Costs of Surfacing and Smoothing Track. D. A. Wallace. (86) July 27.

The Southern Pacific of Mexico Railroad.* L. A. Waterbury. (13) July 28.

Trackless Trolley Systems on the Continent.* (73) July 29.

Locomotives for the Shanghai-Nanking Railway.* (12) July 29.

Mikado Type Locomotive for the Birmingham & Atlantic R. R.* (18) July 30; (15) Aug. 12.

Power Developments of the Lehigh Valley Transit Company.* (17) July 30.

The Central of Georgia Railway Erecting and Machine Shop.* (14) July 30.

Replacing Concrete Roof Slabs, La Salle Street Station.* (14) July 30.

Flamme's Bogie, Belgian State Railways.* (21) Aug.

The Swindon Superheater.* (21) Aug.

Some Details of the Articulated Locomotive Built at the Shops of the Canadian Pacific Railway.* (25) Aug.

Mallet Articulated Locomotives, 2-6-8-0 Type, Great Northern Railway.* (25) Aug.

Express Locomotive with Marine-Type Water-Tube Firebox; Northern Railway of France.* (21) Aug.

Permanent Way of the Egyptian State Railways.* (21) Aug.

New Type Goods Locomotive; Belgian State Railways.* (21) Aug.

Record of Gravel Ballasting, Using Hopper Bottom Coal Cars on a 75 Mile Haul. D. A. Wallace. (86) Aug. 3.

Air Rail Loader.* (15) Aug. 5.

Standard Culvert Tops; Chicago & North Western.* (15) Aug. 5.

Improved Firebox with Hollow Arch and Combustion Chamber.* F. F. Gaines. (15) Aug. 5.

Experimental Mallet Articulated Locomotive.* G. I. Evans. (Paper read before the Canadian Ry. Club.) (15) Aug. 5.

---

* Illustrated.

Railroads—(Continued).

The Irish Railway Commission. (12) Serial beginning Aug. 5.
Steam Turbine Electric Locomotive. (14) Aug. 6.
Methods and Costs of Unloading Spacing and Renewing Ties. D. A. Wallace. (86) Aug. 10.
Methods and Cost of Unloading Railway Rails. D. A. Wallace. (86) Aug. 10.
Engine-House Practice, or the Handling of Locomotives at Terminals to Secure Continuous Operation. F. H. Clark. (96) Aug. 11.
Electrification of Italian State Railway.* Warren H. Miller. (27) Aug. 11.
Heavy Railway Work Along the Des Chutes River, in Oregon.* (13) Aug. 11.
Characteristic Energy Diagrams for Steam Locomotives. W. E. Dalby, M. Inst. C. E. (11) Serial beginning Aug. 19.
Crude Oil Treatment of Ties. E. O. Faulkner. (15) Aug. 19.
The Imperial Peking-Kalgan Railway and its Extension.* J. L. Dobbins. (13) Aug. 25.
Locomotives at the Brussels Exhibition.* (12) Serial beginning Aug. 26.
Proposed Safety Appliance Standards.* (Report of the Interstate Commerce Comm.) (15) Aug. 26.
The Sierra Leone Government Railway.* Edgar Allen Forbes. (15) Aug. 26.
Methods and Cost of Renewing Rail. D. A. Wallace. (86) Aug. 31.
The Wear of Rails on Electrically Operated Railways.* (21) Sept.
Operation of Mallet Compounds in Pusher Service, Delaware & Hudson Co.* (25) Sept.
Articulated Compound Locomotives, 0-8-8-0 Type, Norfolk and Western Railway.* (25) Sept.
Heavy Tank Engines; Northern of France Railways and the State Railways of Saxony.* (21) Sept.
The New Sleeper Depot, Ditton Junction, L. & North Western Railway.* (21) Sept.
"Cascade" or Two-Stage Superheater for Compound Locomotives; Eastern Railway of France.* (21) Sept.
A Norwegian Single Phase Railway.* (15) Sept. 2.
Walschaert Valve Gear.* Benjamin Frey. (15) Sept. 2.
British Railways; Some Facts and a Few Problems. W. E. Dalby, M. Inst. C. E. (Paper read before the Brit. Assoc. for the Advancement of Sci.) (11) Sept. 2; (12) Sept. 2.
New Shops at the Midland Railway Carriage and Wagon Works, Derby.* (12) Sept. 2.
Breakages of Railway Motor Pinions.* Geo. L. Fowler. (17) Sept. 3.
South Cambria 1 200-Volt D. C. Railway.* (17) Sept. 3.
Strengthening Old Trestles on the Wabash Railroad.* (15) Sept. 9.
Mallet and Pacific Type Locomotives; Carolina, Clinchfield & Ohio.* (15) Sept. 9; (25) Sept.; (18) Sept. 3.
A Freight and Passenger Railway using Gasoline Motor Cars.* (14) Sept. 10.
Méthodes Nouvelles pour l'Etude des Tracés de Voies de Chemins de Fer.* P. Le Fort. (32) May.
Locomotive à Marchandises Compound à quatre Essieux Couplés et à Bogie avant de la Compagnie Paris-Lyon-Méditerranée.* (33) July 16.
Note sur le Surchauffer Système Churchward des Locomotives du Great Western Railway.* L. Fort et F. Houlet. (38) Aug.
Note sur la Locomotive Compound à Quatre Cylindres à Trois Essieux Accouplés, Essieu Porteur à l'Avant et Bogie à l'Arrière Série 210 des Chemins de Fer I. R. de l'Etat Autrichien.* Jacques Neblinger. (38) Aug.
Alésoir pour Cylindres de Locomotives Montés sur les Longerons.* (34) Aug.
Lavage à l'Eau Chaude des Chaudières de Locomotives. (34) Aug.
Locomotive avec Foyer à Tubes d'Eau de la Compagnie du Chemin de Fer du Nord.* (33) Aug. 13.
Chemins de Fer Monorails à Gyroscopes Stabilisateurs.* Ch. Dantin. (33) Aug. 20.
Kohlenverladebühnen in Mannheim.* F. Zimmermann. (102) Serial beginning July 15.
Hochlegung und viergleisiger Ausbau der Teilstrecke Potschappel-Hainsberg der Linie Dresden-Chemnitz.* R. Haase and A. Schmidt. (102) Serial beginning Aug. 1.
Gleismeldeanlagen für Wechselstrombetrieb auf dem Verschiebebahnhofe Chemnitz-Hilbersdorf.* E. Besser. (102) Aug. 15.

Railroads, Street.

Bracing and Sheeting Trenches.* Frank H. Carter, Assoc. M. Am. Soc. C. E. (86) July 27.
Comparative Sections of Thirty Retaining Walls and Some Notes on Retaining Wall Design.* Frank H. Carter, Assoc. M. Am. Soc. C. E. (13) July 28.
Boston Elevated Railroad Company's New Tunnel.* (27) July 28.

---

* Illustrated.

Railroads, Street—(Continued).

The Progress of Electric Braking on the Glasgow Corporation Tramway System.* A. Gerrard. (77) Aug.
Pittsburg Transit Problems: Reports by Bion J. Arnold. (13) Aug. 4; (17) July 30; (96) July 28.
Cars, Schedules, Power Consumption, Running Tests and Signals in London Subways.* (17) Aug. 6.
Valuations of the Detroit United Railway. (17) Serial beginning Aug. 13; (13) Aug. 25.
Design of the Fourth Avenue Subway, Brooklyn.* (14) Aug. 20.
Car Tests in Philadelphia with Anti-Friction Bearings.* Arthur B. Stitzer. (17) Aug. 27.
The Electric Welding of Rail Joints in Street Railway Track.* (13) Sept. 1.
Bonding with an Oxy-Acetylene Torch in Minneapolis.* (17) Sept. 3.
Progressive Subsidence near Main St., Cambridge, Mass., and the Design of the Main Street Subway.* Frank H. Carter, Assoc. M. Am. Soc. C. E. (13) Sept. 8.
Valuation of the Track of the Detroit Street Railway System. (13) Sept. 8.
Tri-Borough Subway and Elevated System, New York City.* (14) Sept. 10.
Les Travaux du Chemin de Fer Métropolitain Municipal de Paris à la Traversée de la Seine.* L. Biette. (30) Aug.

Sanitation.

The Possibilities of Rescue-Work in Connexion with Mine Explosions and Fires.* J. S. Haldane. (59) Vol. 32.
Methods and Cost of Constructing Concrete Sewers at Richmond, Ind. Fred R. Charles. (67) July.
Air Conditioning Apparatus; its Construction and Application.* W. H. Carrier. (58) July.
Industrial Safety and the Prevention of Accidents.* William H. Tolman. (98) July.
Travelling Dredge Elevator at Shieldhall Sewage Works, Glasgow.* (12) July 22.
Central Heating at Crawfordsville, Ind.* (101) July 30.
The Heating, Ventilating and Air-Conditioning of Factories.* Percival Robert Moses. (9) Serial beginning Aug.
Garbage Disposal. J. B. Dimmick. (98) Aug.
Some Structural Details of the River Des Pere's Foul Water Sewer at St. Louis, Mo.* (86) Aug. 3.
Some Costs of Small Sewer Work by Day Labor in Baltimore, Md. (86) Aug. 3.
Some Interesting Engineering Features of the Louisville Sewerage.* (104) Serial beginning Aug. 5.
Sewage Disposal of Seaside and Tidal Towns.* A. J. Price. (Paper read before the Inst. of Mun. and County Engrs.) (104) Aug. 5.
Sewage Disposal in the Vicinity of London, England. H. N. Ogden. (14) Aug. 6.
The Fourteenth Street Sewer Tunnel, Washington, D. C.* Asa E. Phillips, M. Am. Soc. C. E. (14) Aug. 6.
A Series of Notable Reports on Sewage Disposal by Dilution at Rochester, N. Y. (13) Aug. 11.
The Operation of the Seattle Refuse Destructor.* (14) Aug. 13.
Operation of the Reading Sewage Purification Works.* E. Sherman Chase. (14) Aug. 13.
The Use of Sulphur and Sand as a Jointing Material for Stoneware Pipe Sewers. (104) Aug. 19.
The Sewage Disposal Works of Mount Vernon, N. Y.* (14) Aug. 20.
Specifications for Determining Cost of Garbage Incineration.* (86) Aug. 24.
Municipal Disinfecting Station at Westminster, England.* (13) Aug. 25.
Rat Suppression for Plague Prevention in San Francisco, Cal. G. M. Converse. (13) Aug. 25.
Sewage Disposal Works at Bushey.* Ernest E. Ryder. (Paper read before the Inst. of Mun. Engrs.) (96) Aug. 25; (104) Aug. 5.
Disposal of City Refuse.* (96) Aug. 25.
Sewage Disposal Works, North Attleborough, Mass.* (14) Aug. 27.
Disposal Methods for Manufactural Wastes. Robert Spurr Weston. (From *Cotton.*) (14) Aug. 27.
Methods and Cost, Preparing and Placing Ashes or Cinders for Filtering Material in Contact Beds.* E. C. Bradbury, M. Am. Soc. C. E. (86) Aug. 31.
The Modern Mosquito Extermination Campaign.* John B. Smith. (13) Sept. 1.
Description of Aerobic Biological Purification of Sewerage by Means of the Live Earth Bed System.* R. B. Owens. (96) Sept. 1.
The Reclamation of Low Lands near Stockton, California.* (14) Sept. 3.
The Operating Control of Sedimentation Plants from the German Viewpoint.* Karl Imhoff. (14) Sept. 3.

---

* Illustrated.

Sanitation—(Continued).

Liability of Gas Companies for Injuries Resulting from Escape of Gas. John Edson Brady. (24) Serial beginning Sept. 12.
L'Aérofiltre Richet.* A. Moreau. (92) July.
La Fièvre Typhoïde à Paris et en Banlieue.* Paul Vincey. (92) July.
Système de Réglage Automatique de la Température et de la Ventilation des Locaux ainsi que de l'Etat Hygrométrique des leurs Atmosphères et ses Applications Industrielles. J.-N. Obozinski. (30) Aug.
Untersuchungen an Ventilatoren für Lüftungsanlagen.* K. Brabbée und M. Berlowitz. (48) July 30.

Structural.

Notes on Wood Preservation and Creosote Production in Europe.* E. A. Sterling. (2) July.
Information in Regard to Fabricated Wire Fences and Hints to Purchasers. Allerton S. Cushman. (96) July 21.
The Extension of the Columbia Building, New York.* (14) July 23.
Concrete Building with Steel Columns in the Lower Stories.* (14) July 30.
Corrosion of Iron Embedded in Concrete.* Guy F. Shaffer. (14) July 30.
The Erection of the Gimbel Building, New York.* (14) July 30.
The Effect of Crystalline Pigments on the Protection of Wood.* Henry A. Gardner. (3) Aug.
Design of Steel Mill Building.* F. E. Davidson. (4) Aug.
Underpinning a Factory Building. F. E. Davidson, M. W. S. E. (4) Aug.
A Device for Making Subsurface Tests of the Bearing Power of Soils with Some Examples of Operation.* (86) Aug. 3.
Reinforced-Concrete Grain Bins for the Storage Annex at Superior, Wis., Great Northern Ry.* O. B. Robbins. (13) Aug. 4.
The Carnegie Swimming Pool at Yale University.* C. S. Farnham. (13) Aug. 11.
Circular Bins for Cement Storage at Dewey, Oklahoma.* (14) Aug. 13.
Structural Steel Details in the Ball Realty Building.* (14) Aug. 13.
Unfilled Voids in Concrete Foundations. (14) Aug. 13.
The Effect of Alkali Water on Cement Mortars. A. J. Fisk, Jr., Assoc. M. Am. Soc. C. E. (13) Aug. 18.
The Design of Large Steel Tanks.* John E. and Wm. S. B. Irvine. (47) Aug. 19.
Reinforced Concrete. Arthur C. Auden, Assoc. M. Inst. C. E. (Abstract of paper read before the Royal Inst. Pub. Health.) (104) Aug. 19.
Hand-Driven Steel Sheet Piling, Bush Terminal, Brooklyn.* F. T. Llewellyn. (14) Aug. 20.
Silicon Steel; Results of Tests made to Show its Superiority over other Kinds.* G. A. Bisset. (20) Aug. 25.
Computation of Reinforced Concrete Flat Slabs.* Louis F. Brayton. (14) Aug. 27.
The Behavior of Hydraulic Compounds in Sea Water.* H. Burchartz. (14) Aug. 27.
Reinforced Concrete Coaling Station, Southern Railway.* (25) Sept.
Integrity of Tests of Metals. Alexander E. Outerbridge. (3) Sept.
The Temperature Coefficient of Resistance of Copper. J. H. Dellinger. (3) Sept.
An Instance of Corrosion of Structural Steel. Dewitt C. Webb, M. Am. Soc. C. E. (13) Sept. 1.
Formulas for Use in Detailing Steel Structures.* Hart Vance. (13) Sept. 1.
The Strength of Guns and Cylinders.* C. A. M. Smith. (11) Sept. 2.
Some Notes on Power Station Chimneys.* E. Killburn Scott, M. I. E. E. (22) Sept. 2.
A Steel and Reinforced Concrete Grand Stand.* (14) Sept. 3.
Grouting Masonry Arches in Hamburg. (14) Sept. 3.
Moving the Front of a Brick Building. (14) Sept. 3.
Two Concrete Locomotive Coaling Stations.* W. E. Witte. (14) Sept. 3.
Fire Hose Tests at the Underwriters Laboratories, Chicago, Ill. Wm. H. Merrill. (Abstract from paper read before the Inter. Assoc. of Fire Engrs.) (13) Sept. 8.
Mechanical Properties of Copper-Nickel Steels made from Electrolytic Iron and Monel Metal.* (13) Sept. 8.
Steel Substructure, Pennsylvania Terminal Post Office.* (14) Sept. 10.
Arêtiers de Charpentes.* P. Sokoloff. (35) Serial beginning July.
La Question des Conduits de Fumées dans les Habitations.* J.-J. Pillet. (92) July.
Le Calcul des Réservoirs Circulaires.* Henry Lossier. (33) July 30.
Essais des Aciers par Corrosion.* F. Cloup. (93) Aug.
Die Standsicherheit von Masten.* Karl Müller. (81) Pt. 5.
Tunnel aus Eisenbeton für das Offiziersheim *Taunus* in Falkenstein.* R. Färber. (51) Sup. No. 15.
Ueber Betonprüfungen und Transportbeton.* D. H. Magens. (51) Sup. No. 16.

---

* Illustrated.

Structural—(Continued).

Siloanlagen der Portland-Zement-Fabrik "Croatia" A.-G. in Podsused bei Agram.* S. Zipkes. (51) Serial beginning Sup. No. 17.
Die Verwendung von Eisen im Hochbau. Fischmann. (51) Serial beginning July 2.
Versuche mit Ferro-Titan-Thermit und niedrigprozentigen Ferro-Titan für Gusseisen und Stahlformguss.* Leonhard Treuheit. (50) July 13.
Uber Inertol. Fr. Krauss. (52) July 15.
Praktische Erfahrungen über künstliche Fundierungen in verbauten Stadtgebieten Osterreichs.* Richard Kafka. (53) Serial beginning July 22.
Kohlenasche und Zusammensetzung des Zementes beim Drehrohrofenbetrieb. W. Hoffmann. (80) July 23.
Gefrorene Mörtel- und Betonmasse. (80) July 30.
Die Bedeutung der Fluorverbindungen für die Holzerhaltung. J. Netzsch. (102) Serial beginning Aug. 1.
Die Berechnung der Durchbiegung von Eisenbetonbalken.* G. Kaufmann. (78) Aug. 2.
Universal-Betondecke "System Gisshammer."* Richard Hoffmann. (78) Aug. 2.
Eine Mechanische Kohlenbeschickungsanlage in Eisenbeton am Neubau der Kesselhausanlage der Gewerkschaft Riedel in Hänigsen bei Burgdorf in Hannover.* Rudolf Giese, Jun. (78) Aug. 2.
Ueber Gründung auf unmittelbar im Boden hergestellte Betonsäulen.* Niemann. (78) Aug. 2.
Zum Berichte des zweiten Gewölbe-Ausschusses.* Fritz v. Emperger. (53) Aug. 5.
Wärmeleitfähigkeit von Isolier- und Baustoffen.* Heinrich Gröber. (48) Aug. 6.
Das Eisengerüst zur Instandsetzung der Andreas-Kirchtürme in Braunschweig.* Gebensleben. (51) Aug. 6.
Sand und Kies. Bretschneider. (From *Zentralblatt der Bauverwaltung.*) (80) Aug. 13.
Die Festigkeit von Fichten- und Kiefernholz. Karl Dorr. (51) Aug. 17.
Zusammenhang der Biegungselastizität des Gusseisens mit seiner Zug- und Druckelastizität.* H. Herbert. (48) Serial beginning Aug. 20.
Der Erhärtungsvorgang des Zementes.* Rohland. (80) Aug. 27.
Einige Schlussfolgerungen aus den von der Betonbauunternehmung N. Rella & Neffe, Wien, vorgenommenen Bruchversuchen mit Plattenbalken.* Genel. (78) Sept. 2.
Versuche über den Einfluss des elektrischen Stromes auf Beton.* W. Gehler (78) Serial beginning Sept. 2.

Topographical.

The "Interval" Method of Determining Elevation in Stadia Surveys.* Adolph F. Meyer. (13) Sept. 1.

Water Supply.

The Water-Supply of Jeypore, Rajputana. (No. II.) Charles Egremont Stotherd. Assoc. M. Inst. C. E. (63) Vol. 180.
Bloemfontein Additional Water-Supply.* Hastings Fitz-Edward Peet, M. Inst. C. E. (63) Vol. 180.
Failure of a Reinforced-Concrete Reservoir.* Ernest Macartney de Burgh, M. Inst. C. E. (63) Vol. 180.
Hankow Waterworks.* Richard St. George Moore, M. Inst. C. E. (63) Vol. 180.
Rating of Pitot Tubes.* H. C. Berry. (2) July.
The Sterilisation of Water by Chlorine and Ozone. G. Sims Woodhead. (Paper read before the Royal San. Inst.) (104) Serial beginning July 22; (96) Aug. 4.
A Reinforced-Concrete Conduit Operating under a Head.* (14) July 23.
A Mechanical Filter for the Removal of Iron.* (14) July 23.
High-Pressure Fire Protection System at Oakland, Cal.* (14) July 23.
The Shoshone Dam of the United States Reclamation Service; a Description of the Method of Constructing the Highest Dam in the World.* D. W. Cole, M. Am. Soc. C. E. (14) July 23.
Driving the Laramie-Poudre Irrigation Tunnel in Colorado.* (13) July 28.
The Plymouth Water Undertaking.* Frank Howarth. (Paper read before the Inst. of Mun. and County Engrs.) (104) July 29.
The Wood Pulp and Paper Mills of the Anglo-Newfoundland Development Co.; a Large Hydro-Electric Scheme.* (73) Serial beginning July 29.
Barrow-in-Furness New Water Supply. (12) July 29.
The Boulder Hydroelectric Plant.* (14) July 30.
Poor Pipe Causes Red Water in Springfield. (14) July 30.
The Water Supply System of Santiago, Cuba.* H. F. Cameron, Assoc. M. Am. Soc. C. E. (14) July 30.
The Examination of Water by Electrical Methods.* W. Pollard Digby. (77) Aug.

---

* Illustrated.

Water Supply—(Continued).

Water-Pollution and Water-Purification at Jersey City, N. J.* C.-E. A. Winslow. (4) Aug.
Conservation of Water Powers. Lewis B. Stillwell. (42) Aug.
Electric Power in the Construction of the Los Angeles Aqueduct.* E. F. Scattergood. (42) Aug.
Availability of Underground Waters for Manufacturing Purposes: Methods of Securing Such Waters, with Some Costs. W. M. Booth. (Paper read before the Amer. Inst. of Chem. Engrs.) (86) Aug. 3.
The Great Northern Railway Tumwater Power Plant.* Frank C. Perkins. (96) Aug. 4.
Piping Charged with Causing Rusty Water: Report of an Investigation in Springfield, Mass. (101) Serial beginning Aug. 6.
The Appleton Water-Works Decision.* (14) Aug. 6.
The Water-Works of Monterrey, Mexico.* (14) Aug. 6.
Water Softening Plants of the Florida East Coast Railway.* A. C. Tomlinson. (13) Aug. 11.
Field Assay of Water.* R. B. Dole. (13) Aug. 11.
Determination of the Resultant Angle in Laying out Combined Bends for Pipe Lines.* C. A. Jackson. (13) Aug. 11.
Effect of the Length of Penstock on the Weight of Revolving Parts of a Water-Wheel Unit. George M. Peek. (13) Aug. 11.
The Water Supply of Jerusalem. (14) Aug. 13.
Water Purification Plant, Putnam, Conn.* (14) Aug. 13.
Capital City Plant, United Missouri River Power Company.* (14) Aug. 13.
Laying a 30-In. Pipe Line under the Pequonnock River.* (14) Aug. 13.
Construction Methods and Organization in Constructing the Buffalo Water Works Tunnel.* (86) Aug. 17.
Experiments on Small Weirs and Measuring Modules.* J. C. Stevens, Assoc. M. Am. Soc. C. E. (13) Aug. 18.
Irrigation in the Okanagan and Thompson Valleys, British Columbia. A. E. Ashcroft. (Paper read before the Irrig. Convention.) (96) Aug. 18.
Hydroelectric Development of the Arizona Power Company.* R. S. Masson. (14) Aug. 20; (27) Aug. 18.
A Michigan Hydroelectric Development.* (27) Aug. 25.
Hydroelectric Development of the United Missouri River Power Company.* (27) Aug. 25.
Report of the Flood on the Zuni River, Sept. 6, 1909.* H. F. Robinson, Assoc. M. Am. Soc. C. E. (13) Aug. 25.
A Reinforced-Concrete Pumping Cistern Sunk into Place in the Ground.* W. Dewitt Vosbury. (13) Aug. 25.
Stoney-Gate Dam in the Albula Canyon for the Hydro-Electric Power Plant of the City of Zurich, Switzerland.* K. E. Hilgard, M. Am. Soc. C. E. (13) Aug. 25.
Hydroelectric Development of the Michoacan Power Company.* Irwin C. McBride. (14) Aug. 27.
Combined Fire and Domestic Service Pumping Plants.* (14) Aug. 27.
Some Experience in Treating High-Colored Water from the Penobscot River at Bangor, Me. (86) Aug. 31.
The Elizabeth Tunnel.* W. C. Aston. (45) Sept.
Results of Double Filtration Experiments at Albany.* (14) Serial beginning Sept. 3.
Valuation of the Fond du Lac Water-Works. (14) Sept. 3.
Water Pipe Tunnels in Milwaukee.* (14) Sept. 3.
Irrigation by Pumping on the Patterson Ranch.* G. C. Stevens. (14) Sept. 10.
Some Rules for Water-Works Appraisals. (14) Sept. 10.
Rolling Dams for Irrigation in Mexico.* (14) Sept. 10.
Le Siphon en Béton Armé d'Albelda sur le Canal d'Aragon et Catalogne (Espagne).* Mariano Luiña. (33) July 23.
Der Nil als Kulturträger in alter und neuer Zeit.* Paul Gerhardt. (49) Pt. 7-9.
Das Elektrizitätswerk Sterzing.* Hans Baudisch. (53) July 29.
Das Wasserkraft-Elektrizitätswerk am Salts de Bolarque.* K. Meyer. (48) Serial beginning Aug. 20.
Versuche über die Druckverteilung in den Laufzellen arbeitender Reaktionsturbinen.* A. Pfarr. (48) Aug. 27.

Waterways.

The Reconstruction of the Tyne North Pier. Ivan Collingwood Barling, M. Inst. C. E. (63) Vol. 180.
Reconstruction of the Canal-Boat Lift on the River Weaver at Anderton.* John Arthur Saner, M. Inst. C. E. (63) Vol. 180.
Dock and Wharf Equipment.* John Llewellyn Holmes, M. Inst. C. E. (63) Vol. 180.

---

* Illustrated.

Waterways—(Continued).

East Boston Deep-Water Terminal of the Boston and Albany Railroad.* Luis G. Morphy. (Paper read before the Bost. Soc. Civ. Engrs.) (1) July.
Foreshore Protection.* (12) July 15.
Methods and Costs of Midwinter Surveying; the St. Louis and Cloquet River Surveys, Minnesota.* C. R. Adams, Assoc. M. Am. Soc. C. E. (13) July 28.
Progress on the Cape Cod Ship Canal. (14) July 30.
The Siphon Lock on the Barge Canal at Oswego.* (From *Barge Canal Bulletin.*) (14) July 30; (86) Aug. 10.
Wharf Construction at Fort Mason, California.* (14) Aug. 6.
The Harbors of Great Britain, with Some Reference to those of North Europe and North America. J. V. Nimmo, M. Can. Soc. C. E. (Paper read before the Sociological Soc. of Great Britain.) (13) Aug. 11.
Machinery and Equipment on the Panama Canal Works.* (12) Serial beginning Aug. 12.
St. Andrews Rapids Dam.* H. P. Borden. (12) Serial beginning Aug. 12.
Measuring the Flow of Large Streams.* Franklin Van Winkle. (64) Aug. 16.
Reinforced Concrete Sea Wall Constructed of Separately Molded Members.* (From *Concrete and Constructional Eng.*) (86) Aug. 24.
Methods of Employing Concrete in Marine Structures with Data on Durability of Concrete in Sea Water and Examples of Typical Marine Structures of Concrete.* Chandler Davis. (Abstract of paper read before the National Assoc. Cement Users.) (86) Aug. 31.
The Mechanism of River Beds.* V. Lokhtine. (10) Sept.
Bank Protection at the Missouri River Bridge, C. M. & P. S. Ry.* (18) Sept. 3.
Hoisting Boats Electrically, the Anderton Electric Driven Canal Boat Elevator.* Frank C. Perkins. (19) Sept. 3.
Couverture d'une Partie du Canal Saint-Martin à Paris, par une Voûte en Beton Armé.* Mesnager. (33) Serial beginning July 30.
Le Rapport de la Commission Chargée de Rechercher les Causes des Inondations et les Moyens d'en Empêcher le Retour.* A. Dumas. (33) Aug. 13.
Les Travaux du Nouveau Canal de l'Erie dans la Traversée de Little Falls (Etat de New-York).* Edmond Henry. (33) Aug. 20.
Uber die Abhängigkeit der Formen der Riffeln und Geschiebebänke vom Gefälle.* H. Blasius. (49) Pt. 7-9.
Die künstliche Dichtung des Kanalbettes in der Scheitelhaltung des Grossschiffahrtweges Berlin-Stettin.* Schliemann. (49) Pt. 7-9.
Betrachtungen über Ebbe- und Flut-Theorien.* O. Franzius. (81) Pt. 5.
Das Höchstwasser des Donaustromes bei Wien.* Ernst Lauda. (53) Aug. 12.
Das generelle Regierungsprojekt für die Ergänzung der Hochwasserschutzmassnahmen in der Wiener Donaustromstrecke.* Ernst Lauda. (53) Aug. 12.
Wien von den Hochfluten der Donau dauernd bedroht.* Anton Waldvogel. (53) Aug. 12.
Die neuen Rheinwehre oberhalb Basel.* Krieger. (51) Serial beginning Aug. 13.

* Illustrated.

Vol. XXXVI. SEPTEMBER, 1910. No. 7.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

CONTENTS

Papers:

PAGE

The Arch Principle in Engineering and Esthetic Aspects, and Its Application to Long Spans.
By C. R. GRIMM, M. AM. SOC. C. E. 1208

Rust, as Shown in the Removal of a Seventeen-Story Building.
By T. KENNARD THOMSON, M. AM. SOC. C. E 1224

The Failure of the Yuba River Débris Barrier, and the Efforts Made for Its Maintenance.
By H. H. WADSWORTH, M. AM. SOC. C. E. 1226

Memoirs:

GEORGE HUNTINGTON THOMSON, M. AM. SOC. C. E 1237
VARDRY ECHOLS MCBEE, JR., ASSOC. M. AM. SOC. C. E. 1240
RALPH CARROLL SOPER, ASSOC. M. AM. SOC. C. E. 1241

PLATES

Plate CLXII. Comparison of Three Kinds of Long-Span Bridges 1213
Plate CLXIII. Details of Yuba River Débris Barrier, Spillway, etc 1227
Plate CLXIV. Views of Yuba River Débris Barrier 1229
Plate CLXV. Scour at Toe of Barrier; Excavation for Spillway, etc 1231
Plate CLXVI. Views of Barrier Before and After Its Destruction 1233
Plate CLXVII. Views After Destruction of Barrier 1235
Plate CLXVIII. Views Showing Damage to Apron and Second Slope 1237

Vol. XXXVI. SEPTEMBER, 1910. No. 7.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE ARCH PRINCIPLE IN ENGINEERING AND ESTHETIC ASPECTS, AND ITS APPLICATION TO LONG SPANS.

By C. R. Grimm, M. Am. Soc. C. E.

To be Presented November 2d, 1910.

The object of this paper is to present some suggestive designs for a bridge with several spans accommodating railroad and street traffic across a wide river, the channel span to be approximately of the greatest length thus far used in practice, so that simple trusses are out of the question.

Much has been written on the subject of long-span bridges, but it is far from being exhausted. Apparently there is yet much to learn regarding the construction of great bridges, and a thorough discussion of designs will bring out facts of undoubted value.

Girders and trusses, if acted on by vertical loads in their planes, can be divided into two distinct types: one including all those having vertical reactions, and the other those having inclined reactions. The second type represents the arch principle, which does not recognize any particular form of chords, but depends on the conditions of the supports. Thus, for instance, a girder or truss with parallel and horizontal chords is still governed by the arch principle, if the plane of contact of the supports is inclined.

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

While the first type, with vertical reactions, is properly used for very great spans, the second type is not economical for ordinary lengths, but is most suitable for such spans as are here under consideration, in fact, it is the only type to be considered for the maximum length of span which is practicable.

The cantilever truss, which is a notable example of the first type, will first be considered. The writer does not wish to say that, for a very long span, such a truss should never be built, because there may be isolated cases where it would be acceptable, but he does say that, on general principles, the cantilever truss is not by any means the most desirable of the many forms which may be designed for very long spans. If one insists on great rigidity and, comparatively speaking, on small deflections, and especially on economy, one must look for other trusses; the advantage that the cantilever trusses can be erected without falseworks is shared by other forms. Still another point to be noted refers to the secondary stresses to which trusses of every kind are subjected. In a cantilever truss it is particularly that part above and adjacent to the pier which is susceptible to severe secondary stresses, and, quite generally speaking, the selection of a truss should be made with due regard to these stresses. Wherever high secondary stresses may be expected (and also in doubtful cases) the designer should take account of them. The assumption that, in such cases, this matter is settled by the simple expedient of a little reduction in the amount of the unit stresses, may be convenient and comfortable, but it is certainly quite insufficient. Further, there is no doubt that the designer of a bridge of any kind is obliged to give it a satisfactory appearance, but the most that can be said of a cantilever bridge is that the configuration of its trusses may be designed in such a manner as to be inoffensive.

Another type to be considered is the continuous truss, which may be built if a sound rock foundation can be had. Having naturally a very great mass for a long span, it would be exceedingly sensitive to the displacement of its supports, and therefore great care should be taken in building its masonry, so as to avoid a large surplus of metal to meet any possible changes in the stresses. The secondary stresses in a continuous truss run rather high, especially in those parts which are over the supports. The tonnage of steel required is not particularly attractive, if compared with others, but it is superior to a cantilever truss in point of stiffness and deflection, the latter being considerably smaller than in a cantilever truss. From an esthetic point of view, the continuous truss is just as difficult to treat as the cantilever truss.

There are still other forms from which the designer may select. For example, he may choose a truss having four points of support, in connection with wire cables or chains, and may fasten the ends of these to the ends of the truss so as to produce vertical reactions; but, whatever he may choose in this line will fail to give the desired results. The satisfactory solution of the problem points in some other direction.

Trusses of the second type, with inclined reactions, will next be considered. These are represented by suspension and arch bridges, and show a multitude of variations; they differ in essential details and in their relations to statics; and, if they are statically indeterminate, they share in a peculiarity which is common to all such structures. Apart from the fact that the analysis of their stresses is derived from the same point of view, the run of their stresses is more uniform and does not show such violent changes as are sometimes observed in statically determinate structures, a fact which may be of practical value.

A suspension bridge would solve the problem, provided great care was taken in its design as a railroad bridge, but the writer does not consider it the best solution. Skilfully designed, the bridge proper shows economy and has a pleasing appearance, but it also has disadvantages. The tonnage is influenced considerably by the anchor chains and anchorages, and particularly by the towers and the general stiffness. Further, it is to be noted that the effects due to temperature changes and yielding of the anchorage masonry, and also the deflections, are considerably greater in suspension bridges than in arches. It is very difficult to inspect the anchorages, which is a serious drawback, as the safety of the bridge is dependent on them, and the anchorage masonry is a very costly item.

A suspension bridge with a hinge at the center of the span is rejected, as it shows excessive deflections and a lack of stiffness, which are obstacles to fast-running trains. Continuous trusses are preferred on account of their stiffness, a quality which is valued in a truss as well as in a floor system.

Attention is now called to arches. It is somewhat strange that these bridges have never been as highly developed in America as other forms of bridges. It does not appear to be necessary to discuss in detail the various forms of arches which are practically possible, on the contrary, some general statements will suffice. Spandrel arch bridges are excluded from consideration, for technical and esthetic reasons, and also the three-hinged arch as it has the same objectionable features as the suspension bridge with a center hinge. Further, any arch which throws the thrust against the river piers must be excluded.

The two-hinged arch rib deserves very careful consideration, provided its form is properly chosen and it is given the necessary depth, as it is a remarkably stiff and safe structure, with small deflections, only influenced moderately by temperature changes, and therefore well suited for railroad purposes. Arch bridges of very long spans are more economical than other truss bridges, which is well shown by the crescent arch. Moreover, this rib, if of great depth, is a favorable truss in regard to secondary stresses which, as stated before, should be given due consideration before a particular truss is selected. In the present case it would be admissible, for the calculation of secondary stresses, to assume the moments of inertia of the web members equal to zero, so that the moments of two adjacent chord sections are equal to each other. On account of the points just stated, the crescent rib is selected as being a very fit type for the purpose, not merely for technical, but also for esthetic reasons, which will be shown later. This statement does not imply that other truss types are unworthy of study. The engineering features of the subject will be taken up first, and then some remarks will be given on the esthetics of bridges.

The writer has made estimates of weights for bridges of widely different designs, three arch bridges, a cantilever, and a suspension bridge. It is obvious that these are, of necessity, only approximate, as exact estimates can be based only on complete designs. These estimates are naturally governed by the same conditions, but, under the present circumstances, as many points, otherwise important, cannot even be touched, these conditions will be stated quite briefly.

The bridges are supposed to be of nickel steel throughout and to accommodate two tracks for steam railroad service, the remainder of the floor being intended for other traffic. Each bridge has a central span of 1 800 ft. between end supports, and two shore spans, each 540 ft. between end supports, with two lines of main trusses

85 ft. from center to center. The main panels are from 90 to 100 ft. long, and are subdivided where practicable. The railroad stringers are estimated for the wheel concentrations of *E* 80, and each of the other stringers for a uniformly distributed live load of 2 500 lb. per lin. ft. The assumed live load for the main trusses is a uniformly distributed load of 16 000 lb. per lin. ft. per span, and of infinite length, and to be cut into sections, where necessary, to obtain the maximum stresses. The effects of dead and live load, impact, braking forces, wind pressure, change of temperature, and secondary stresses have been considered. For the main trusses, a limit of stress of 30 000 lb. per sq. in. has been assumed, and properly reduced for compression members, covering the stresses due to dead and live load, impact, and temperature; and for a combination of all the stresses previously mentioned, a limit of 37 500 lb. per sq. in. The stresses in the floor, suspenders, and posts outside of the main trusses, are supposed to be at least 20% less than the above limits. For the suspension bridge the stresses in the cables are assumed to be 60 000 and 75 000 lb. per sq. in., corresponding to those for nickel steel. These unit stresses are immaterial, as the comparative bridge weights are the objects sought.

Each of the three forms of arch bridges to be considered, called *A, B* and *C,* Plate CLXII, has each line of trusses arranged as follows:

A.—Three crescent arch ribs, all three ribs coupled;

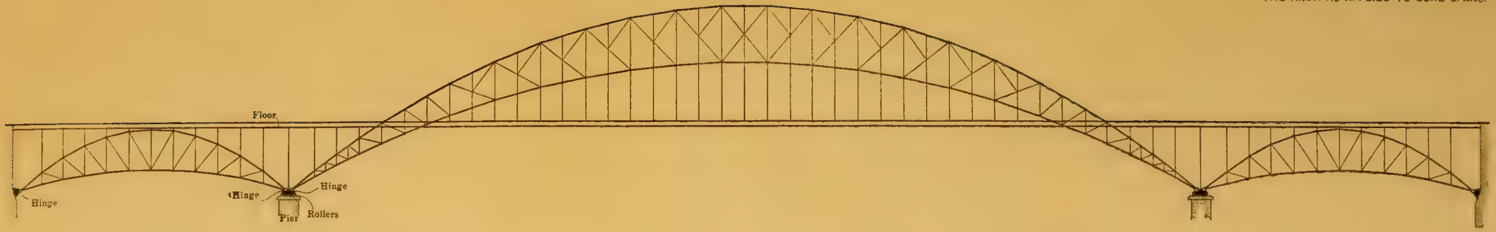
B.—Central crescent arch rib and two simple side trusses with horizontal bottom chords, all three trusses coupled;

C.—Two cantilever side trusses, each 940 ft. long, carrying a crescent arch rib of 1 000 ft. between end hinges.

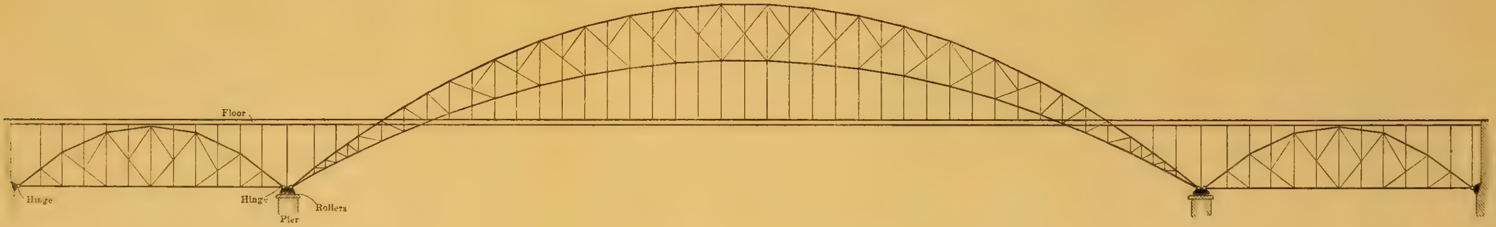
Each of these three structures is statically indeterminate in the first degree, and each is assumed to have fixed hinges on the shore masonry and roller shoes on the piers, so that the thrust is delivered at the shore instead of at the pier, an obvious and great advantage. The adjacent ends of the trusses over the piers have a common hinge, or have separated hinges, but in either case a common roller shoe. The small horizontal force due to the frictional resistance at the roller shoes may be disregarded.

In Bridge *A* the rise of the bottom chords of the river and shore trusses above the springing line is 250 ft. and 40 ft., respectively,

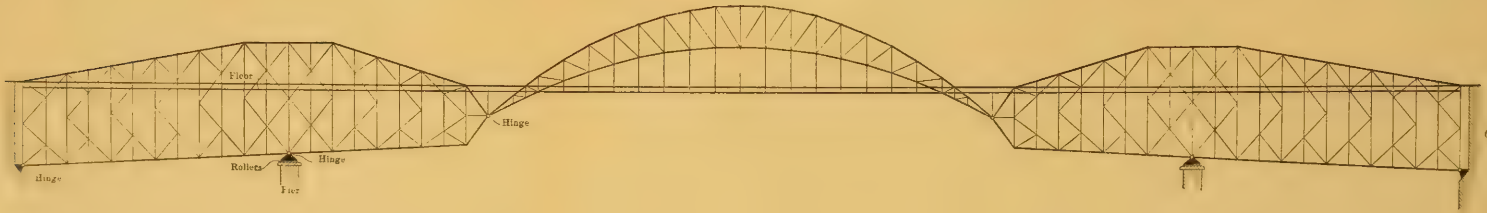
PLATE CLXII.
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1910.
GRIMM ON
THE ARCH AS APPLIED TO LONG SPANS.



A



B



C

and the depth of the trusses at their centers 110 ft. and 80 ft. The clear height above high water is assumed to be 150 ft. for a distance of from 1 200 to 1 300 ft. Both chords of each truss are parabolic. The floor consists of floor-beams and stringers, and its loads are transferred to the main trusses, partly by suspenders and partly by vertical posts. Provision is made for a wind bracing with wind chords in the plane of the floor, and wind bracings between the bottom chords of each span, also vertical sway bracings at every panel point. These bracings, together with two main trusses, form a truss in space; they make the structural system complete and stiff, and, besides, they have the advantage of giving the construction a lighter and better appearance.

All questions relating to wind forces are more or less problematic, but they should not be made more so by comfortable assumptions which are not free from criticism. The effect of the wind force on such a large structure is very important, and, as the overhead bracing in this case is in a curved plane, computations can and should be used which will allow one to judge of the axial stresses, not only in the chords, but also in the web members of the trusses. Bending stresses due to wind force are a secondary consideration.

The general character of the 1 000-ft. and the 540-ft. arch ribs is the same as that of the 1 800-ft. rib in Bridges *A* or *B*.

The trusses of the deck spans in Bridge *B* have a supposed depth of about 120 ft., and the cantilever trusses in Bridge *C* a depth of about 220 ft. over the piers.

It is further assumed that the cantilever bridge with vertical reactions has a suspended span of about 700 ft. and a height of trusses over the piers of about 300 ft., while the suspension bridge has stiffening trusses with parallel chords, but the end spans are not suspended from the cables. The dip of the latter is 250 ft.

The structural work for all bridges is supposed to be of simple design, and to conform to the best practice of to-day.

The estimates of the probable weights of these five bridges give the following results:

Cantilever bridge	70 000	tons.
Suspension bridge	60 000	"
Arch bridge *A*...........................	53 000	"
Arch bridge *B*...........................	45 000	"
Arch bridge *C*...........................	45 000	"

As might have been expected, the cantilever bridge is the heaviest. This tonnage of steel required for a cantilever bridge is excessive, and an explanation of this fact is found in the cantilever principle itself, as its use involves a very crude way of controlling great forces.

The suspended structure of a suspension bridge is an economical construction, but when it is considered that anchorages, anchor chains, and particularly gigantic towers more than 400 ft. in height are required to enable the structure to do its work, it is not surprising to find most of the economy in steel wiped out. In any case, a high degree of efficiency and safety will cost very dearly.

Comparing the weights per linear foot of the cantilever spans with vertical reactions with those of the side spans in Bridge *A* it is found that they amount to 25 tons in both cases, but this weight does not include the influence of the anchorages and tower footings of the cantilever spans or the truss bearings in Bridge *A*. The economy of the latter consists in the weight of the central span, which is 24 000 tons without truss bearings. The writer is of the opinion that, owing to their massiveness, the shore spans in Bridge *A*, although their length compared with that of the river span is as 3 : 10, harmonize perfectly with their function of carrying vertical loads and a great thrust. For a particularly heavy bridge such as this one, an advantage is gained by building twin trusses instead of single trusses for the short spans, which would facilitate the work in the shop and in the field.

It can be seen at a glance that the weight of Bridge *B* must be less than that of Bridge *A*, because, in the former, the thrust is taken in the most direct way by the horizontal bottom chords of the side spans.

The weight of Bridge *C* is accounted for by the economy of the arch span, estimated at 9 500 tons, and the combined influence of this weight and the thrust of the arch on the weight of the cantilever trusses, the configuration of which, naturally, also plays a rôle. A 1 000-ft. arch and short cantilever arms insure to this bridge considerable stiffness with moderate deflections, and if the designer succeeds in giving the cantilever trusses an inclination downward toward the shore, so much the better.

In actually designing such bridges, very thorough consideration should be given to the depth of the trusses; and an investigation should be made of the ratio of length between shore and river span and between cantilever arm and suspended arch, from both economical and esthetic points of view. The writer's principal aim consists in laying before the reader the principles involved in these structures, rather than their weights.

The possibilities of arched steel ribs are far reaching, and do not depend on the fact that special brands of steel may be used in their construction. It would not be surprising if an arch bridge of suitable design was easily victorious in competition with a stiffened suspension bridge having a main span far exceeding 1 800 ft.; but a discussion of such large spans, together with their erection, is beyond the scope of this paper.

The stability of the 1 800-ft. central span against wind pressure has been examined. Under the assumption that the two trusses of the unloaded arch, two sets of suspenders and posts, and a solid floor 10 ft. deep are exposed to the action of a horizontal wind force of 50 lb. per sq. ft., the total pressure was found to be about 2 400 tons and the resisting moment about two and one-half times greater than the wind moment. The stability of this span is further increased in no small degree by its anchorage to the piers and its connections with the end spans.

The safety of a bridge, being of paramount importance, deserves the most thorough examination from all points of view. The safety of a suspension bridge has been referred to as being dependent on the fixity of its anchorage masonry, and, in any case, that such a bridge is far more sensitive to a yielding of its supports than an arch bridge. Some suppositions will now be made which may appear extraordinary, but which the writer thinks will bring out the point concerning the effects of yielding supports. Let it be assumed that the depth of the 1 800-ft. rib in Bridge *A* is changed to one-tenth of the span, that is, 180 ft. at its center, and, further, that its form is selected so as to correspond to the moments, but that no essential change is made in the weight of the span. If, in this condition, the abutments would yield to the extent of reducing the thrust to zero, so that the trusses of all three spans would act with only vertical reactions, even then the central ribs under their own weights would survive the injury, but by stressing the steel nearly to the elastic limit, the shore spans, of course, suffering far less, or nothing at all, as the case might be. These spans are intended to carry a great thrust in addition to their own loads, and are therefore abundantly able to take care of themselves, even with vertical reactions exclusively. Although the reduction of the thrust to zero may be improbable, its realization, nevertheless, is within the range of possibilities, for example, by an earthquake. Similar remarks hold true for Bridge *B*.

Under like assumptions and circumstances, a suspension bridge would be doomed to destruction long before the pull in the anchor chains reached the zero value. The point the writer wishes to make is that the safety of a suspension bridge against the consequences of any pronounced yielding of the masonry is incomparably less than that of an arch bridge with extra deep crescent ribs.

In case of severe injury to the shore masonry, bridges with very deep arch ribs also show a far greater safety against collapse if compared with common cantilever bridges or spandrel arches. The peculiar configuration of these latter trusses is irrational when it is considered that it shows the least depth at its center where it should be a maximum for any reduction in the thrust; and, of course, the greater this reduction the greater is the danger from excessive stresses. Deep crescent arches in any of the bridges, *A*, *B*, or *C*, meet in a natural way the conditions of increased safety, in contradistinction to the suspension and common cantilever bridge and the spandrel arch.

Before concluding this part of the paper it is necessary to refer to the manner of erecting the central spans of arch bridges. The smaller spans in Bridge *C* can be erected as guyed cantilevers, but the writer is of the opinion that the erection of the longer span is best effected on falseworks, for as many end panels as advisable, and as a guyed cantilever, if necessary, for the remainder of the span. Should it be found impracticable to carry the end panels of the longer span on falseworks, then the ribs could be erected as guyed cantilevers, or the construction of more than two trusses might be considered, as it would reduce the weight of the trusses and ease their erection. Convenient places of anchorage may be found in the heavy end spans.

Although the erection of an 1 800-ft. arch span can be effected successfully, it is, nevertheless, a very serious problem, and connected with risks great enough to make extraordinary means appear to be a necessity. On this account the writer would like to have a discussion of certain features in a design—provided they are permitted as proper—which are intended to reduce greatly the difficulties and risks connected with the erection of such a large span, and at the same time insure other advantages.

Assume an arched truss in connection with a wire cable as a permanent carrying member, the ends of which are fixed in the same manner as in a suspension bridge. In such a case it is within the range of possibilities that the slackening of the cables will expose the truss to the danger of overstressing; but, if means are taken to remove this danger entirely such a design may be considered as admissible. For instance, the difficulty may be overcome by fixing one end of the cable and providing the other end with a counterweight, or by using counterweights of unequal magnitude and avoiding the fixity of the cables altogether, or by counterweights of the same magnitude, one of them being anchored.

A notable example of the use of counterweights is furnished by the Loschwitz Suspension Bridge across the Elbe, in Germany, a bridge having a total length of about 880 ft., that is, 480 ft. for the central span and 200 ft. for each side span. It is to be noted, however, that in this case the counterweights are intended for a purpose different from that proposed herein.

Counterweights in a bridge such as characterized do not change the statical nature of the trusses. They are known quantities, therefore the stresses in the cables and suspenders are known and constant quantities. The size of these weights may be controlled by proper arrangements of lever arms.

The advantages connected with such a construction may be summarized as follows:

1.—The cables take a part of the load from the trusses, so that the compression members are very considerably reduced in size;

2.—The counterweights are open to inspection, a matter of undoubted and great importance;

3.—The cables are free from temperature stresses;

4.—The safety of the bridge against collapse is increased; and

5.—The bridge can be erected in a manner similar to that of a suspension bridge.

The other part of the problem is of an esthetic character, and is important enough to deserve very careful examination, on account of the unusual size of the bridges. Observations have led the writer to believe that judgments in esthetic questions are very much at variance, so that a discussion of the principal points of this subject seems to be timely, especially as the writer is not aware that these points have ever been brought very prominently before this Society.

In the nature of things, the design of a bridge must first fulfill all necessary technical and economical requirements before the esthetic side of the problem is taken up, and, consequently it is natural that the freedom of the bridge engineer in esthetic questions is more or less limited; therefore, whenever an opportunity presents itself, he should not let it pass, but, either alone, if he has the necessary qualifications, or in co-operation with an architect trained in bridge esthetics, he should endeavor to produce a work which will find general approval.

In this brief discussion the writer refers particularly to an arch bridge, but in the endeavor to make his meaning clearer, it is necessary to state some facts which are of a general character.

The esthetic effect of an arch bridge is enhanced if several conditions are realized, but the simultaneous existence of these is a rarity. These conditions consist in the symmetry of the structure; an odd number of spans and decrease in their length from the middle of the bridge toward the ends; if there is more than one span, the passing of the floor across the crown or crowns of the arches; and, moreover, for a highway bridge, a gentle rise of the floor from the ends toward the middle. Desirable as these conditions appear, they are nevertheless accidentals, and cannot be put forward as the cause of the satisfaction felt in viewing an esthetic structure; the finding of the true cause of this satisfaction, however, is the vital point of the discussion, carrying with it a hint to shape a design so that it will be esthetically effective.

Fitness cannot be regarded as causing the esthetic effect of a bridge, because a bridge may be perfectly fit for the purpose intended and be ugly at the same time; or, its effect may be esthetically satisfactory, while it may be entirely unfit for its purpose.

Decoration is another element to be considered in a bridge design, but is a mere addition, going beyond the utility of a structure. Forms of art, properly designed and wisely distributed, contribute to the appearance of a bridge, but they do not indicate the reason for real esthetic satisfaction. These embellishments can only be appreciated at close range, and are dwarfed into insignificance, if a bridge is viewed from a distance; but, the full effect of a structure can only be had from a proper distance.

It is quite natural to suppose that the arch line has something to do with the question, and it certainly has, but, considering it by itself —a mere curve—it can never be the cause of admiration.

Finally, it may be stated that neither taste nor style has any relation to this genuine satisfaction, at least, not in the case under consideration, as will be seen later. One must look in some other direction for the conditions of approval, and, in fact, these can only be found if an esthetic object is contemplated from a higher point of view, but an exposition of the relations between observer and object and a scientific explanation of the esthetic phenomena do not concern the engineer, as these are problems to be solved by metaphysics. Art is not an exclusive domain of the selected few—the intellectual leaders of the age—and only understood by them. It is an educational power—at least it should be—for a whole people, from which it follows that works of art must be understood by the masses to a considerable degree, if they are to be appreciated.

Taking this idea as a starting point, it may be asserted that the true arch is commonly understood, and, further, that it satisfies the esthetic feeling better than any other form of bridge; and now some substantial statements may be advanced in support of these assertions.

As to the first assertion, it is necessary to remind the reader of a simple fact. A load acting in the plane of an arched body—for instance, a segment of a ring which is supported at its ends—will spread these ends still farther apart. This is the way an arch acts, a simple phenomenon, stripped of all technicalities, understood anywhere and by everybody. The like cannot be said of every other form of bridge. There are, of course, some simple forms which are commonly understood, but they are lacking in certain elements, so that they will never surpass the arch in point of esthetics; it is not in their nature that they should. There are also bridge forms which require some effort for their identification. The designer, of course, knows exactly the way his mechanism will act, no matter how complicated, but the masses do not. However, they do know the arch at sight, are attracted by it, and understand its action.

The second assertion, containing the kernel of the discussion, requires the presentation of some facts which the writer believes will expose the true cause of esthetic satisfaction.

Esthetics is that science which sets forth the principles of art deduced from Nature. Looking at the case in the light of this idea, it can be maintained that beauty in the works of the engineer, as in Nature, springs from the same source, and that in both cases (disregarding some elements of lesser importance) it consists principally in the manifestation of physical forces. The more clearly and perfectly the relations between these forces are expressed in the works of the engineer, or, in other words, the more closely his constructions approach an idealization of these relations, as between strength, load, and resistance, the more powerful will be the esthetic effect. An effective manifestation of the physical forces, however, is dependent on certain conditions which, if fulfilled, greatly enhance the esthetic effect. These conditions are mainly of an objective character, and they are: Intensity of expression, extension or size, uncommonness, and energy.

Take, for example, the force of gravity acting upon every substance. Its expression in stone and steel is more intense than in the lighter materials, and it is precisely for this reason that a stone or steel bridge is more pleasing than a wooden bridge.

Size plays a great rôle, and, in fact, it may be a source of the keenest pleasure. A bridge of any kind built on a very large scale gives a favorable impression, while the same bridge built on a small scale or represented by a model creates only indifference.

The first two conditions, of course, are complied with by any great bridge, but the case is different with the last conditions.

As to uncommonness, it is to be noted that phenomena of rare occurrence excite interest. A force like that of gravity acting along a vertical line is a common phenomenon, it is constantly before our eyes, so that it has ceased to interest us, certainly not in any marked degree, while, on the contrary, the appearance of inclined or horizontal forces strike the mind as something new, and awaken interest. These latter forces are observed in those bridge forms which are governed by the arch principle.

The particular point, however, to which attention is called is the idea of energy, for in no form of bridge is this idea so irresistibly forced upon the mind as in the true arch, built either in steel or stone.

The beholder of an arch can see with his mind's eye the physical forces putting forth all their power to spread the ends of the arch still farther, flinging a thrust sideways against the supports to meet its counterpart. It is this fight for supremacy, between opposing forces, the display of the tensest energy, the strength of the arch in action, the parry of a thrust and its safe guidance to the earth, which ever appeal to the imagination and reveal the beauty. Try as one will, one cannot ignore that thrust. It must have been this activity of the arch which gave rise to the significant and striking saying* of the old Hindus: "The arch never sleeps."

In a flat arch of long span the activity of the material is highly pronounced, and the struggle of forces is so strenuous that one actually speaks of the boldness of the construction.

If it is correct to see in the arch principle or in the way an arch acts the true cause of esthetic satisfaction, then this explains why bridges without this principle suffer a loss in esthetic effect, even to the point of its complete disappearance. Take as an illustration a truss with vertical reactions, but built like an arch. Here the arch principle has been severed from the arch line, the life has been taken out of the structure, it has been converted into a sham, and the esthetic effect is lost.

In viewing a great truss bridge with vertical reactions, the consciousness of the activity of the steel is not by any means as vivid as it is with an arch; it may be quite feeble, and it may even be extinct. One is impressed with the size and strength of the structure, but it is strength in repose—a giant asleep.

If the cantilever principle, as embodied in the common cantilever bridge, were exposed in its nudity to the mind of the observer, the carrying of the suspended span by the cantilever arms would produce in him a feeling of insecurity—of a possible disaster. The prevention of this feeling is accomplished by a trick played on his imagination by making the trusses appear to be continuous, and, at the same time, effectively confusing his understanding of their true action.

A suspension bridge, properly designed in every respect, is a handsome structure, although some features are to its disadvantage in an esthetic sense. A steel bent or tower, for instance, carrying the cables and anchored down at its base, contradicts the function of a column, because a column is intended to carry only vertical loads, and should not be subjected to the action of horizontal forces. Hinged ends and corresponding outlines of the tower or bent indicate, therefore, an improved appearance. The layman's idea of the action of a stiffening truss is anything but clear, and, owing to his limited knowledge of the great carrying capacity of a wire cable, it must appear to him as a rather slender member to carry the great loads which may be put on a long span. Further, these cables extend to a considerable length across a river on one side from the top of a tower, while toward the shore they are much shorter. Here the layman is confronted with a puzzle which possibly he can solve only after long and very careful cogitation. The unequal lengths of a cable with respect to the two sides of a tower make it difficult for him to balance the forces and when, with his eye, he follows the cable toward the shore he sees it suddenly vanish somewhere down into the earth, the opposing forces are completely hidden from his observation. Indeed, neither is the action of a suspension bridge as easily understood nor is the energy displayed in such a high degree as it is with the arch, where the struggle of forces is thrown into bold and naked relief.

---

* "History of Indian and Eastern Architecture," by James Fergusson.

The question which form of arch deserves preference in point of esthetics presents itself as natural, and, in order to reach a decision it is only necessary to compare an arched rib with a spandrel arch. Even the untrained observer is satisfied with the arched rib as representing a physical symbol of the arch line existing in his imagination, especially if the rib has a constant depth, but he finds it difficult to obtain a realization of the arched line in the spandrel arch. The peculiar configuration of this truss deprives it in a considerable degree of its character as an arch, and this fact, coupled with the discovery of the smallest depth at the center of the span, where it is least expected, is the cause of confusion in his mind. The abrupt termination of the spandrel arch, that is, the perpendicularity of its high ends, obscures the expression of thrust, while the crescent arch, in which the two chords converge toward the springing line, is a form of truss best suited for the expression of a powerful and penetrating thrust which is parried by the quiet strength of the support.

It is seen, then, that, from the viewpoint of esthetics, the spandrel arch is unfit for large spans, and should only be used for small ones, while the arched rib must be considered as the correct form. Here the transfer of the loads to the rib by posts or suspenders, and also the power of the rib to carry these loads, is expressed clearly and unmistakably, in contradistinction to the spandrel arch.

The superiority of the crescent rib over other forms of trusses in certain cases should prompt an engineer to give it careful consideration. Properly designed, it is very efficient, safe, and economical; its free span length can be pushed far enough to satisfy any demand which is likely to be put forward, and, in point of esthetics, the arch bridge has no equal. The writer considers the ribbed arch as a source of the tensest energy, and, in fact, the only source of energy at the command of the bridge engineer.

The writer's investigations have led him to the conclusion that a skilfully designed arch bridge is superior in every respect to any cantilever or suspension bridge, and on this account he has offered these few suggestions. There are still other trussed arch bridges worthy of study which deliver the thrust against the shore masonry instead of against the river piers, and are essentially different from those considered herein, but, as the writer made no investigation of them (from lack of time), they are not presented for discussion.

An ideal solution of the problem requires exhaustive studies of a great number of designs. A body of engineers charged with such a work would have its hands full, but, if not hampered by financial considerations, the result would be a bridge which could hardly be surpassed.

An investigation with a view to determine the greatest feasible length of span of an arch rib has never been made. Such a length is largely dependent on the method of erection, which, in turn, may influence the character of the design.

Vol. XXXVI. SEPTEMBER, 1910. No. 7.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

RUST, AS SHOWN IN THE REMOVAL OF A SEVENTEEN-STORY BUILDING.*

By T. Kennard Thomson, M. Am. Soc. C. E.

The Gillender Building, a seventeen-story structure at the northwest corner of Wall and Nassau Streets, New York City, was built in 1896, and removed in 1910.

When built, all the columns were encased in solid brickwork. The steelwork received one coat of paint in the shop and two after erection, but on removal, showed little evidence of ever having been painted at all.

From the top to the bottom, wherever the spaces between the brick and steel were filled with Portland cement mortar, there was no rusting, but, wherever the mortar did not fill such spaces completely, rusting had begun. Generally, the under sides of the top and bottom flanges of the floor-beams had begun to show rust, while the web and upper surfaces, having been in contact with mortar, were in good condition.

The worst rusting of all was from the sixth floor down, on the northeast corner, where the columns had been against the adjoining building, on the north side. The cover-plates of these columns looked as if they had never been painted, but had stood in the open, exposed to all weather, for 6 or 7 years. On these columns one-half, in volume, of many rivet heads could easily be removed.

---

* This paper will not be presented at any meeting, but written communications on the subject are invited for publication with it in *Transactions*.

This building had been erected by first-class contractors and with first-class materials; and although the rusting had not yet made the building unsafe, there is no telling how soon it would have become so.

It would seem that if the columns had been encased and filled with wet concrete there would have been little danger of rust, and they could thus have been easily protected from electrolysis. Oil or oil paints should not be placed on steel to be thus encased.

Messrs. Trowbridge and Livingston are the architects for the thirty-nine-story Bankers' Trust Building which will take the place of the Gillender Building, and Messrs. Marc Eidlitz and Son are the contractors, to whom the writer gives his thanks.

Vol. XXXVI. SEPTEMBER, 1910. No. 7.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE FAILURE OF THE YUBA RIVER DÉBRIS BARRIER, AND THE EFFORTS MADE FOR ITS MAINTENANCE.

By H. H. Wadsworth, M. Am. Soc. C. E.

To be Presented November 16th, 1910.

The structure on the Yuba River which has been commonly known as "The Barrier" was one of those forming the system of works to restrain the movement of hydraulic mining débris down the Yuba and into the Feather and Sacramento Rivers. Some portions of this system are now in operation, and others are in course of construction.

A general description of the project and of its several constituent parts, including details of construction and photographs, may be found in a paper, entitled "The Control of Hydraulic Mining in California by the Federal Government,"* by William W. Harts, M. Am. Soc. C. E., Major, Corps of Engineers, U. S. Army. The reader is referred to this paper for a history of the experiments leading up to the design and construction of this barrier.

The barrier failed on the night of March 17th and 18th, 1907, during the unprecedented flood that set new standards as to flood heights and stream flow, of the Sacramento River and all its tributaries, for engineers dealing with reclamation and flood control prob-

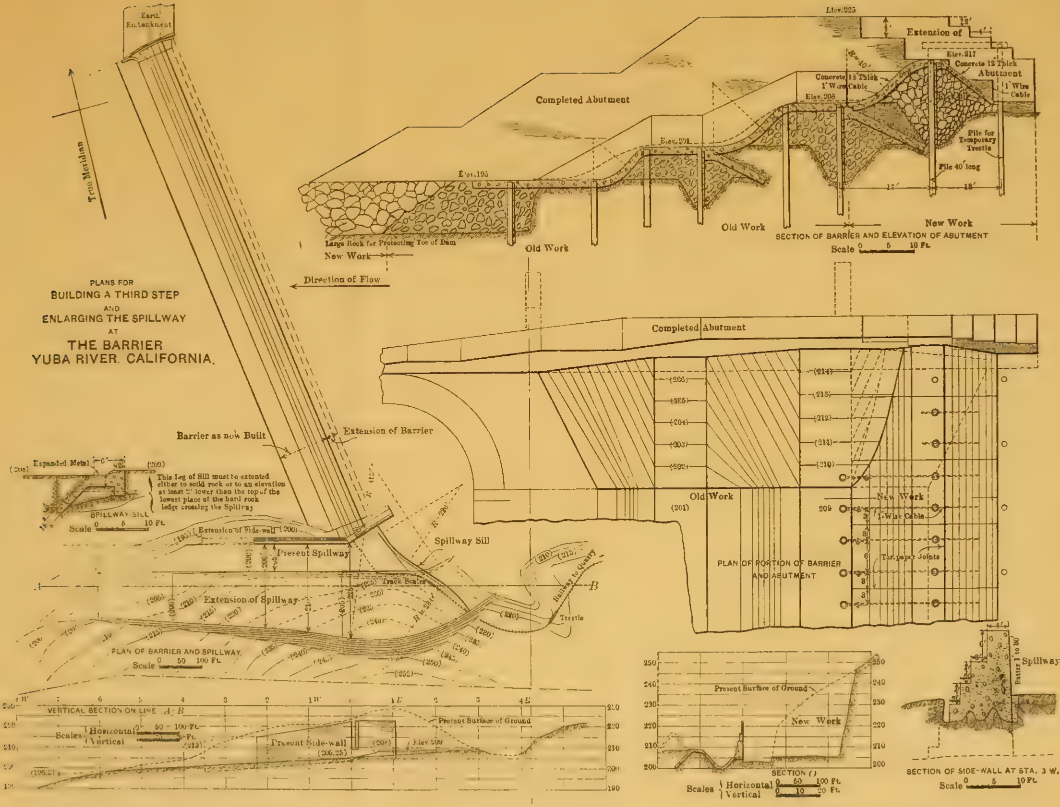
---

NOTE.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

* *Transactions*, Am. Soc. C. E., Vol. LVII, pp. 20-26.

PLATE CLXIII.
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1910.
WADSWORTH ON
YUBA RIVER DEBRIS BARRIER.

PLANS FOR BUILDING A THIRD STEP AND ENLARGING THE SPILLWAY AT THE BARRIER YUBA RIVER, CALIFORNIA.



lems. This flood forms the subject of a paper, by Messrs. Clapp, Murphy, and Martin, entitled "The Flood of March, 1907, in the Sacramento and San Joaquin River Basins, California." *

The writer's connection with the Yuba River works began at about the time the contract for the second step of the barrier was let. Under the direction of the California Débris Commission, his efforts, in so far as that structure was concerned, were directed toward maintaining and safeguarding it. Notwithstanding its unfortunate destruction, engineers still manifest considerable interest in the barrier, as well as in other features of the system of débris restraining works. This fact, together with a special request of the Board of Directors of the San Francisco Association of Members of the American Society of Civil Engineers, has induced the writer to prepare this paper, in the hope that something of advantage to the Engineering Profession may be gained by its presentation.

As stated by Major Harts, two steps of the dam were built, 6 ft. and 8 ft., respectively, making a total of 14 ft. above what was the bed of the river when the first step was built. The first step was backed up by tailings on the occurrence of the first high water after its completion. Likewise, during the first flood following the completion of the second step, tailings banked it up to its crest, and subsequent high waters carried large quantities of gravel over the dam, which caused considerable wear on the concrete surface. At the same time, the water, with its increased velocity, due to its drop, caused extensive scour at the toe.

In 1906, it was decided not to raise the dam by an additional step, but to devote all the energy possible to excavating a spillway and constructing the side-wall for it, and to increasing the output of the quarry to a maximum for use in toe protection.

The Yuba River, the flow of which ranges from a minimum of about 400 sec-ft. in summer to a maximum of 125 000 sec-ft. during extreme floods, maintained, during May and June and well on into July, 1906, a flow of between 10 000 and 20 000 sec-ft. On account of the arrest of the passage of débris by the dam, which would continue to be effective, though in lessening degree, until the accumulation above it had been built up to a slope approximately parallel to the

---

* *Transactions*, Am. Soc. C. E., Vol. LXI, p. 281.

former slope of the river bed (about 19 ft. per mile at this point), the flowing water, thus relieved of its load above the dam, was able to pick up a new one below and scour out a channel down-stream from the dam sufficient to prevent a water-cushion from forming there, which would have served as some protection against further undermining action.

Of the more than 5 000 tons of large rock placed at the toe of the barrier in 1905, comparatively little remained in sight by June of the next year, the scouring action having buried it in the gravel. The depth to which scouring action extended was in some places as great as 12 ft. The undermining of the gravel from behind the plank bulkheading of the first row of piles extended back under the dam irregularly, in some places as far as 4 ft. The surface of the river above the dam was 25 ft. above the lower part of the undermined face, but the fact that there was little or no evidence of seepage showed the density of this natural hydraulic fill. During the summer of 1906 this cavity was filled with rock placed by hand, and about 3 500 tons of large rock were added to the rock apron, the theory on which this work was continued being that, as the high-water periods during which excessive erosion occurred were separated by several months' time, it would be possible after each flood to restore the settled rock fill to grade by the addition of new material, and that this process could be continued until the barrier had been raised to its final height. On reaching this point, the spillway, as designed, would have sufficient capacity to carry the entire flow of the river except during a very few days each year.

How vital to the maintenance of the barrier the construction of the spillway was recognized to be is shown by the following consideration. The nearest down-stream point which would limit positively the depth of scour above it was at Daguerre Point Cut, 6 miles away, the sill of which was at Elevation 125. The concrete apron at the toe of the barrier was at Elevation 195. If, by reason of holding back the supply of gravel above, the scour continued below until a slope as flat as 8 ft. per mile up from Daguerre Point was reached, it would then have stood 36 ft. above the bed of the river. The projected height would thus have been reached, but by building downward rather than upward. Bed-rock in the old channel of the river is probably at about Elevation 140, or 55 ft. below the concrete apron of the dam.

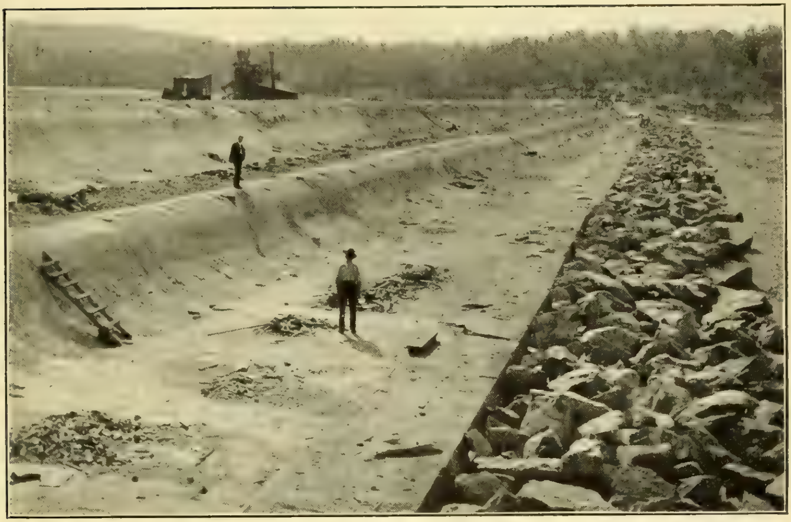


Fig. 1.—Yuba River Barrier, on October 4th, 1905.

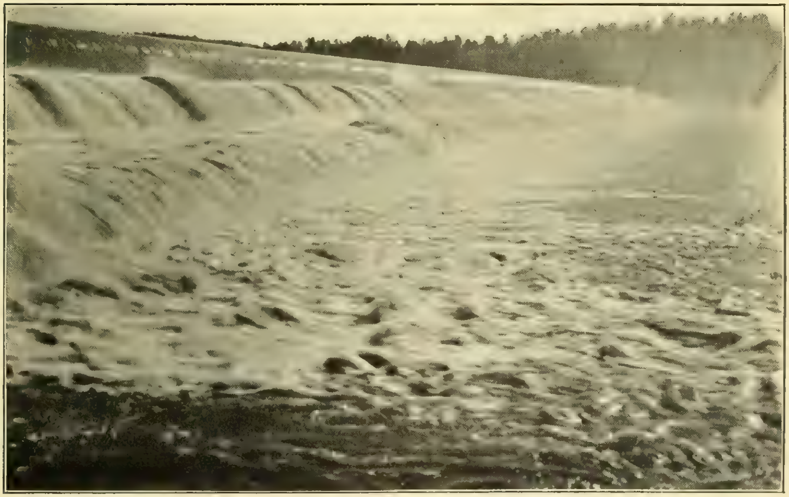


Fig. 2.—Yuba River Barrier After Freshet of January, 1906.
Water 1.4 Ft. Deep on Crest.

During 1906, in addition to repairing the damage at the toe and placing the large rock previously mentioned, a spillway, 65 ft. wide (150 ft. wide at the entrance) was excavated, and a concrete side-wall for it, 320 ft. long, founded on solid rock, was built. The spillway and wall foundation required the excavation of 2 500 cu. yd. of rock and 8 300 cu. yd. of earth. A new railway track, of 25-lb. steel rails, 3-ft. gauge, and nearly level gradient, was constructed from the barrier to the quarry (½ mile), and cars, derricks, additional hoisting engine, etc., were acquired in order that in future the Government might save the expense of the long haul of contractor's plant when a change of contractors occurred.

The first step of the spillway afforded very little relief in floods, but it was capable of carrying the entire dry-weather flow, and would be of great service in constructing additional steps to the barrier, as the difficulties in making the closure and turning the water over the completed structure when the first, and to a much less extent, when the second step was built, would be avoided.

By the time the work of the season of 1906 had been completed the engineers in charge of the Yuba River work had become convinced that the attempt to increase materially the storage of débris by raising the barrier several additional steps, as planned, would be hazardous to the structure until a spillway of the full capacity finally contemplated had been constructed. It may be well to note that the usual risk to interests along a watercourse below a reservoir dam of questionable stability did not exist here, because at no time was any considerable volume of water impounded.

In designing the several Yuba River works, the maximum flow had been assumed at 125 000 sec-ft., which was from 25 to 50% greater than the probable maximum, as indicated by available records. This discharge, however, was nearly, if not quite, reached during the 1907 flood. This meant a depth of water of more than 7 ft. over the 1 225-ft. crest of the barrier. A flood of anything like this volume, however, continues for but a few hours, and a flow of one-quarter of that amount never continues more than a few days. The site of the spillway was a steep hillside, necessitating a much larger amount of excavation to give a cross-section sufficient to carry the desired flow of 20 000 sec-ft. below the level of the crest of the barrier than would have been the case could the barrier have been first built to its projected height. As the further movement of large quantities of gravel over the concrete surface of the dam, already backed up to the crest, was then known to be fraught with serious consequences, it was decided to widen the spillway, without materially raising its floor, and to build one additional step to the barrier, which would increase the depth of water in the spillway by its own height and, on account of the large flow through the spillway, would not be banked up by tailings to its crest, except possibly at its north or farther end.

In order that the extensive work contemplated might be done during the season of 1907, plans were prepared and a contract let much earlier in the season than had been customary on previous contracts. On February 23d a contract was awarded for building a third step to the barrier, 8 ft. high, enlarging the spillway, extending both the spillway side-wall and the north abutment, constructing a sill across the spillway, and placing large rock at the toe of the barrier. The general plan for this work is shown on Plate CLXIII. The approximate quantities were as follows:

Earth excavation	78 000	cu. yd.
Rock excavation	15 000	cu. yd.
Concrete	3 150	cu. yd.
Piles	210	
Lumber	5 500	ft. b. m.
Rock fill, including sluicing of sand and gravel	7 000	tons
Large rock for toe protection	5 000	tons
Wire cable (1-in.)	7 400	lin. ft.
Expanded metal	2 700	lb.

The approximate estimate of cost was $124 000.

Work was started at once. The contractor made arrangements with a water company for water, to be delivered at a point above the site of the work, which would give 100-ft. head; and a plant was partly installed for making the earth excavation of the spillway by using a jet and sluicing. The necessary stripping in the quarry was commenced.

From January 31st to February 2d there was a severe storm. The flow of the river, as deduced from depths on the barrier and in the spillway, rose to 80 000 sec-ft., and a large volume of gravel passed over the dam. The water continued to be too high to permit of a

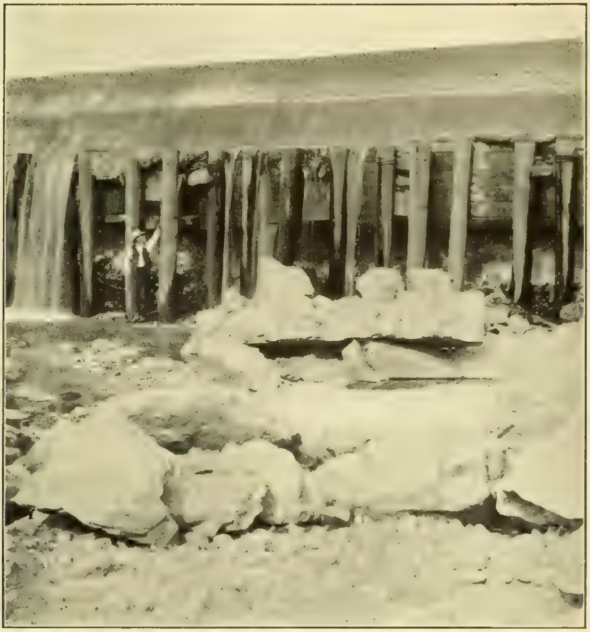


FIG. 1.—MAXIMUM SCOUR AT TOE OF BARRIER, SUMMER OF 1906.

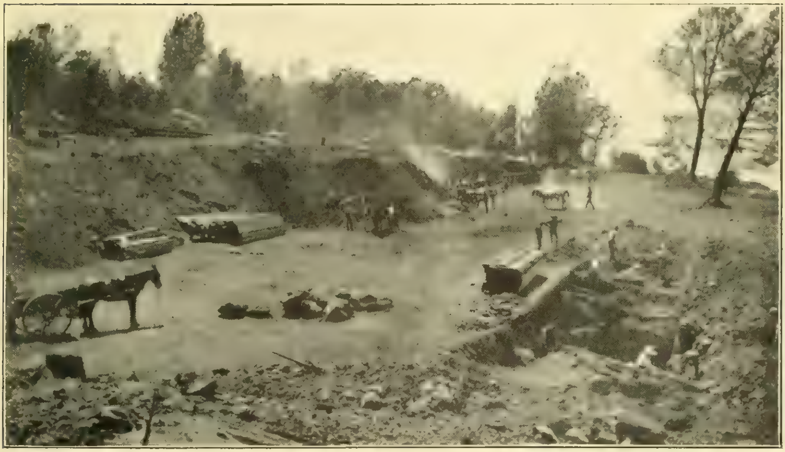


FIG. 2.—EXCAVATION FOR SPILLWAY AND FOR FOUNDATION OF SIDE-WALL IN PROGRESS, IN SEPTEMBER, 1906.

critical examination of the structure, but its appearance, as viewed from either end, did not differ noticeably after this flood from that before. In fact, the rate of scour at the toe seems to have been greater at somewhat lower stages than at maximum flood stage, the reason being that the outlet channel from the pocket eroded from below the toe was of insufficient capacity to carry the flood without backing it up to a considerable extent, thus forming a water-cushion.

Had this February flood been the last of the season, as might reasonably have been expected, the barrier would probably have been still standing, with but little doubt as to its permanency, as the maintenance would have been a much simpler matter after the completion of the contract then in force. However, the disastrous flood already referred to, which was of greater volume than had ever theretofore been reliably recorded, occurred in March, and during the night of the 17th and 18th of that month about one-half of the barrier was swept away. The contractor's camp was not more than 500 ft. distant, but no one there knew of the failure until the next morning. Water marks in the vicinity showed that before failure the depth on the crest was 7.5 ft. at the south end and 6.5 ft. at the north end.

When seen by the writer, a few days later, the river-bed through the breach presented the same smooth gravel surface that had marked it before the barrier was started, with only one or two piles, having pieces of the wire rope anchorage attached, projecting above the surface, about 100 ft. down stream from the line of the dam.

Either of two causes may have been immediately responsible for the failure: first, the undermining of the structure by back-lash; or, second, the wearing away of the concrete surface of the apron and first step, 18 in. thick, thus permitting the rapid washing out of the rubble rock fill. There was not time, nor did the flow of the river diminish enough between the two floods of February and March, to permit of any addition being made to the rock fill at the toe of the dam, or of any repairs to the concrete surface.

Considering the conditions at the toe of the dam on the day before the failure, as reported by reliable witnesses, and the appearance of that part of the structure still standing, which adjoined the part washed out, the writer is convinced that the concrete surface for a considerable length was literally worn away by the great quantity of hard quartz cobbles and gravel which passed over it.

Plates CLXIV to CLXVIII show the conditions at the barrier during the summer and fall preceding, and the spring following the failure.

Some notes on the design of the spillway, as shown on Plate CLXIII, may be of interest. The stepped form of the cross-section of the side-wall is due to the fact that it was originally designed with special reference to future enlargement to the requirements of a dam 14 ft. higher than that of the modified plan. The spillway was designed to carry 20 000 sec-ft. of water before any passed over the barrier. For different depths of water on the crest of the barrier, the total discharge of the river would be distributed approximately as shown in Table 1.

TABLE 1.

Depth on barrier.	Discharge over barrier.	Discharge through spillway.	Total discharge.
0	0	20 000	20 000
1	4 400	23 300	27 700
2	13 000	25 700	38 700
3	24 000	29 300	53 300
4	38 000	30 900	68 900
5	54 000	33 400	87 400
6	71 000	36 100	107 100
7	90 000	38 600	128 600

A comparison of these estimated capacities with the actual estimated flow of the river, as determined from gauge heights at the barrier, indicates that, had this spillway been constructed, water would have flowed over the barrier during the period from July, 1905, to March, 1907, on only 5 days in January, 4 days in March, 1 day in May, and 3 days in June, 1906, and on 4 days in January, 3 days in February, and 17 days in March, 1907. The depth on the crest of the barrier would have exceeded 1 ft. on only 4 days in January, 1906, and on 2 days in January, 4 days in February, and 4 days in March, 1907. It would have exceeded 2 ft. on only 2 days in January, 1906, and on 1 day in January, 2 days in February, and 2 days in March, 1907. Considering the fact that practically all the scour occurred when the depth on the crest was between 1 and 3 ft., it will be seen that, with the spillway completed, the period of scour would be limited to a very few days, even during such a flood season as that of 1907; and it should be remembered that that record had not been made when the spillway was planned.

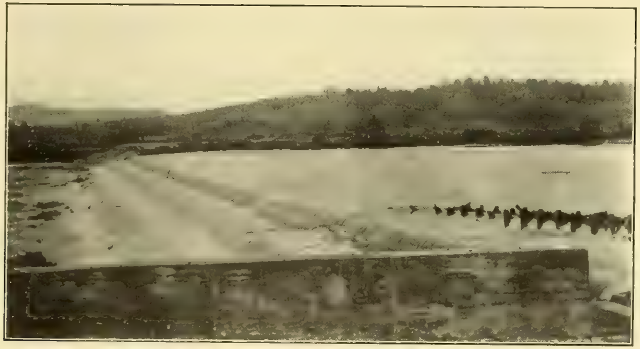


FIG. 1.—VIEW OF BARRIER IN NOVEMBER, 1906, LOOKING NORTH.
SIDE-WALL OF SPILLWAY IN FOREGROUND.

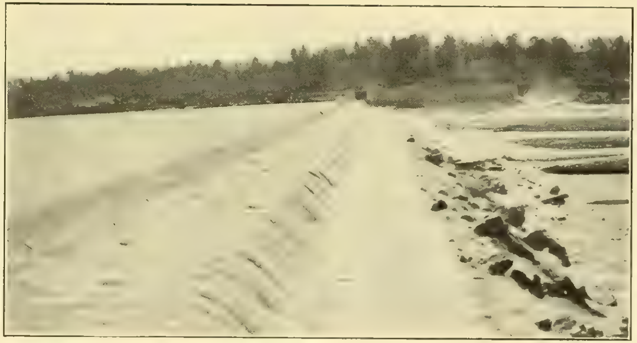


FIG. 2.—VIEW OF BARRIER IN NOVEMBER, 1906, LOOKING SOUTH.
SIDE-WALL OF SPILLWAY IN BACKGROUND.

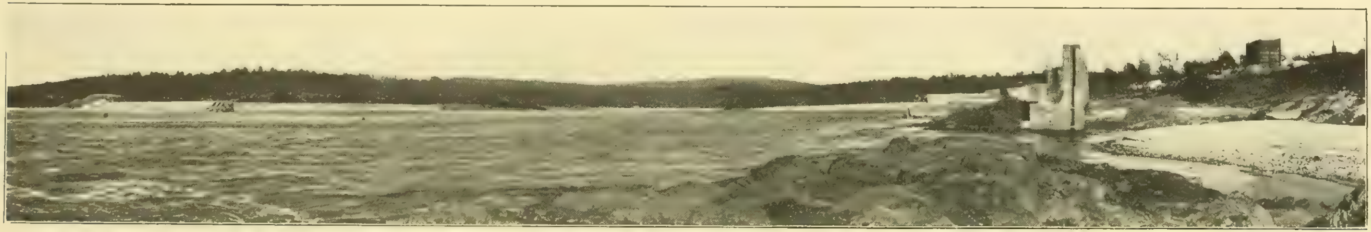


FIG. 3.—PANORAMIC VIEW ON MARCH 28TH, 1907, AFTER THE DESTRUCTION OF THE BARRIER.

The hillside through which the spillway excavation was to be made had a slope of about 1:5 and was of very irregular formation. The south abutment of the barrier was founded on a ledge of hard blue rock, either trap or diorite, having a specific gravity of nearly 3.1. The outcropping rocks on the hillside consisted of boulders and the pinnacles which are characteristic of this region and which, below the surface, vary in structure from hard trap to soft chloritic rock or serpentine, and to decomposed rock and clay. When sinking drill holes in this formation a difference of 2 ft. in position would frequently make a difference of many feet in depth to hard rock, and even then there was no assurance that ledge had been reached. For this reason the exact location of the sill was left indeterminate. It was to be located as far up stream as a suitable foundation would permit. The crest of this sill, 2 ft. wide, was to be 8 ft. below the crest of the new step of the barrier. The concrete surface was then to have a drop of 1 ft., on a 45° slope, followed by a 3-ft. level surface. From this point the floor of the spillway was to have a gradient of 1.25 per cent. The plan of the spillway and the gradient were adjusted to give the greatest capacity for the least amount of excavation.

In determining the widths of the spillway at successive sections, the depth was assumed to be constant and the velocity was calculated by a formula which the writer found developed in a paper, entitled "The Velocity of Water Flowing Down a Steep Slope,"* by E. P. Hill, M. Inst. C. E. The formula was simplified by the writer to the form

$$V = \left[V_1^2 + \frac{1}{\varepsilon^{\left(\frac{V_H}{V_1}\right)^2}} (V_1^2 - u^2) \right]^{\frac{1}{2}}$$

where $V_1 = C \sqrt{r\, S}$, the usual formula for velocity in watercourses,
$V_H = 2\, g\, H =$ the velocity, due to gravity, of a body falling freely,
$u =$ the velocity of approach, and
$\varepsilon =$ the base of the Napierian logarithms $= 2.718$.

This formula is based on two assumptions: that the experimental values of C in the ordinary watercourse formula are applicable to high velocities; and that, within narrow limits, the hydraulic mean radius may be taken as constant at its mean value. The mathematical derivation of this formula is somewhat involved, but all the steps were checked by the writer, and he believes that it gives safe results. The velocity of water flowing in a channel on a steep slope will, of course, continue to increase until the acceleration due to gravity is counteracted by the increased frictional resistance. When this point is reached, $V = u$, and the formula reduces to $V = V_1 = C \sqrt{r S}$, as it should.

---

* *Minutes of Proceedings*, Inst. C. E., Vol. CLXI (1904–05), p. 345.

That the applicability of this formula is not limited to slopes of small degree is shown by the fact that for high values of S, as for instance $S = 0.707$ (45° slope) or $S = 1$ (vertical drop), substituting numerical values for h and r, reduces the expression to the form $V = \sqrt{a + b u^2}$, in which a is but little less than $2gH$ and b is almost unity; that is, the value of V is very little less than $\sqrt{2gH + u^2}$, which would be its value were it influenced by gravity alone.

Applying this formula to the barrier spillway gives the necessary widths at successive points by the steps tabulated below. In laying out the spillway, these widths were departed from slightly for simplicity and for other considerations.

Depth of water above sill = 8 ft.,
Depth of water below sill (1 ft. drop) = 6.3 ft.,
Value of r (below sill) = 6 (constant through spillway),
Velocity of water at foot of sill = u = 10 ft. per sec.,
$S = 0.0125$; $n = 0.030$; then $C = 67.6$,
$V_1 = C \sqrt{r S} = 18.51$;
W = width of spillway.

TABLE 2.

Vertical distance below sill = H.	Corresponding horizontal distance.	V_H	$\frac{1}{\varepsilon^{\left(\frac{V_H}{V_1}\right)^2}}$	V	Area of section to carry 20 000 sec-ft.	W
0	0	0	0	$u = 10$	2 000	318
1	80	8.03	0.8295	11.89	1 685	268
2	160	......	......	(13.2)	1 525	242
3	240	......	......	(14.35)	1 393	221
4	320	16.06	0.4642	15.20	1 315	209
5	400	......	......	(15.8)	1 265	201
6	480	......	......	(16.25)	1 231	196
7	560	......	......	(16.65)	1 201	191
8	640	......	......	(17.0)	1 176	187
9	720	24.09	0.1848	17.29	1 155	183
10	800	......	......	(17.6)	1 136	181
16	1 280	32.12	0.0498	18.4	1 085	173
25	2 000	40.15	0.0066	18.5	1 082	172

PLATE CLXVII.
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1910.
WADSWORTH ON
YUBA RIVER DEBRIS BARRIER.

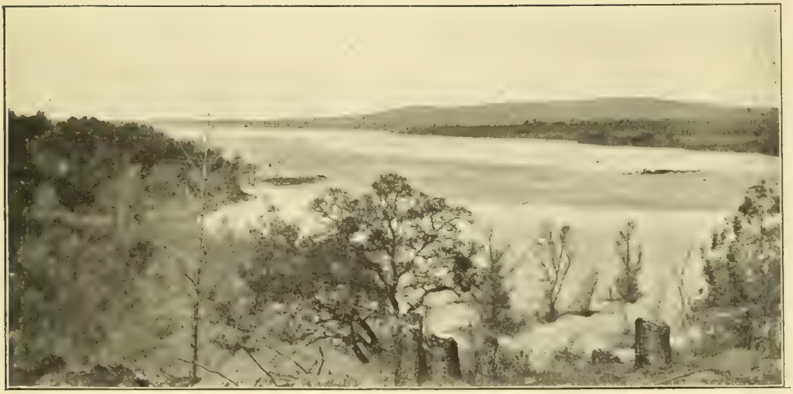


Fig. 1.—Looking Down Stream from the Quarry.

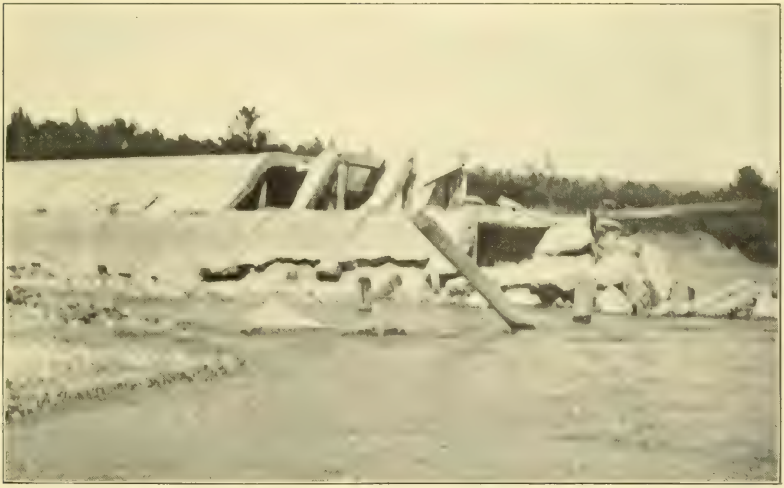


Fig. 2.—Near View of North End of Break.

The values of V in parentheses were not computed, but were taken from the diagram, Fig. 1, which shows the velocity curve.

In addition to the work for the protection of the barrier, already described, which was in progress, a change in the form of its concrete rollway surface was contemplated in connection with the repairs to that surface which had become necessary. When there had been but one step the water followed smoothly in its ogee shape, but when the second step was constructed the increased velocity at its foot caused it to leap over the upper curve of the first, so that, with its load of gravel, it struck the lower or reverse curve well down toward the apron. The impact of the water and gravel on the concrete doubtless greatly increased the wear on the latter. A uniform slope to the down-stream face would probably have carried the gravel down with less wear, but that form was not adopted originally because less weight was given to that fact than to the reduction in the dangerously high velocities which the steps would effect. To transform the stepped face to a uniform slope would have required an excessive amount of concrete.

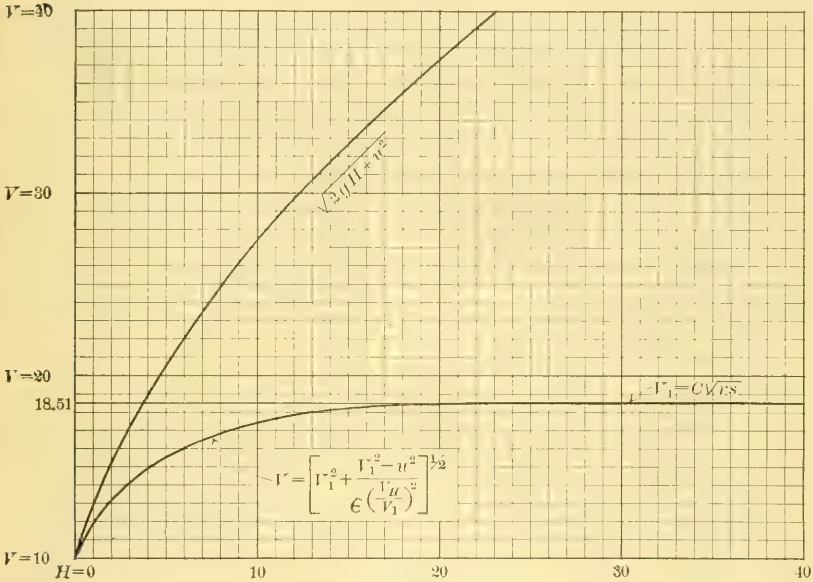


FIG. 1.

A study of the path of the body of water as it leaves the horizontal portion of several succeeding steps, assuming an initial velocity of 8 ft. per sec., shows that, if all the energy acquired in each descent were retained, the radii of curvature of the convex portion of each step, from the top down, to be just in contact with the flowing water would be approximately 2½, 20, and 34 ft., respectively. Assuming that 20% of the energy developed by the fall over each step is dissipated in friction, etc., the horizontal velocity of the water would still be such as to require radii of curvature of 2½, 16, and 25 ft., respectively, for succeeding steps.

In connection with repairing the concrete surface of the barrier, a modification of its form to one approximating that shown by the heavy broken lines on the section, Plate CLXIII, was under consideration.

The destruction of the barrier and the decision to use the further available funds along lines which gave promise of greater efficiency in restraining the movement of débris than would the reconstruction of the barrier, put an end to further consideration of plans for its maintenance.

At present, 3 years after, the site of the barrier presents substantially the same appearance as it did a week after the failure, except that more of the impounded tailings have washed out from the portion still standing.

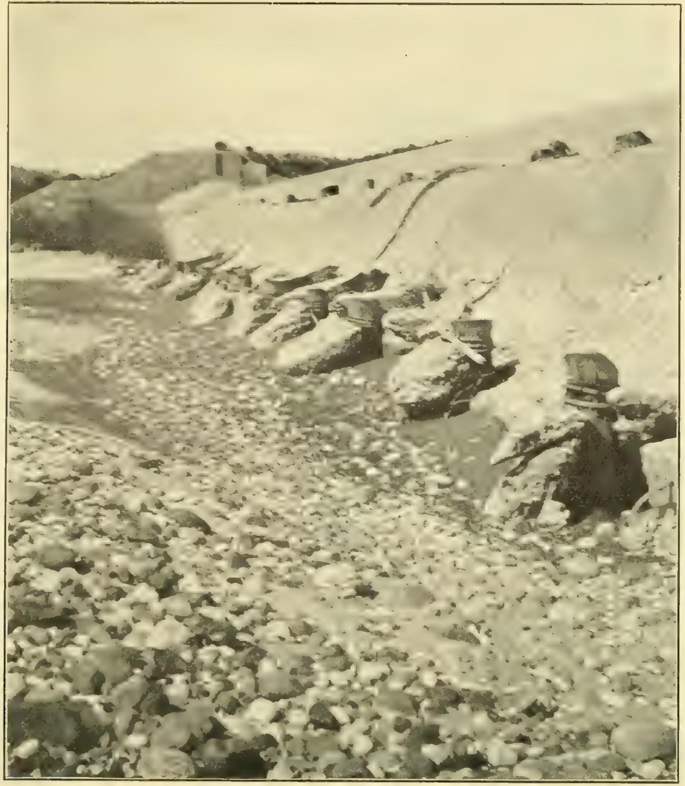


FIG. 1.—CONCRETE APRON OF BARRIER WORN AWAY, EXCEPT SMALL PIECES PROTECTED BY PILES.

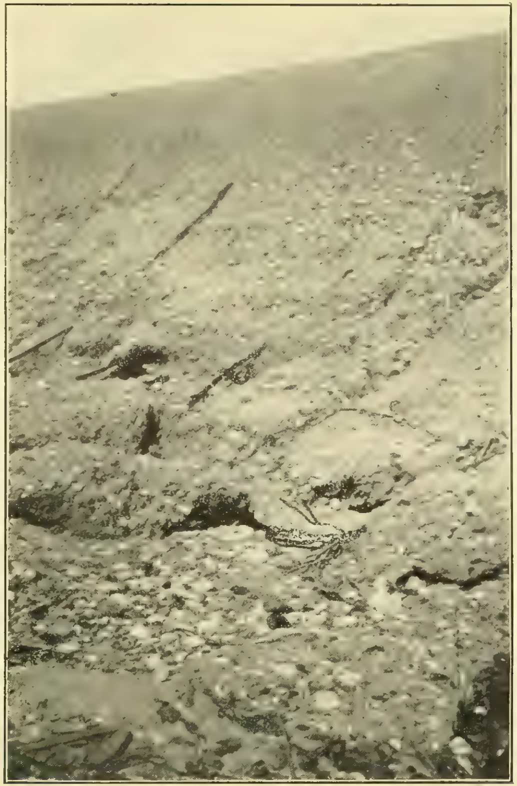


FIG. 2.—HOLES WORN THROUGH CONCRETE AT FOOT OF SECOND STEP.

MEMOIRS OF DECEASED MEMBERS.

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

GEORGE HUNTINGTON THOMSON, M. Am. Soc. C. E.*

DIED FEBRUARY 7TH, 1910.

George Huntington Thomson was born in Syracuse, N. Y., in 1847. He first engaged in engineering work in 1865 when he became Assistant Engineer on the Oswego and Syracuse Railroad (now part of the Delaware, Lackawanna and Western Railway), in which position he remained nearly two years. He then went to New Orleans, La., where he filled a position as Assistant Engineer on Government work for about two years, and later became Resident Engineer on the New Orleans, Mobile and Texas Railroad. He was with the latter company some four years, being located in Louisiana and Mississippi, and was finally promoted to a position in charge of yards, stations, and structures.

From the South he went to the New York Central and Hudson River Railroad, and was connected with that road for twenty-one years, first as Assistant Engineer on track work, then as Engineer of Bridges, and later as Consulting Bridge Engineer. After leaving the service of the New York Central as Bridge Engineer in 1893, Mr. Thomson engaged in a consulting and contracting engineering partnership in New York City, in which he continued until 1900. During this period he was at one time Chief Engineer of the Metropolitan Traction Company, which proposed the construction of an elevated railway line in New York City, a project which was ultimately abandoned. Among his clients as Consulting Bridge Engineer were the New York Central and Hudson River, the Central Vermont, the St. Lawrence and Adirondack, and the Mohawk and Malone Railroads, and at one time he was retained on the construction of the Williamsburg Suspension Bridge over the East River between New York City and Brooklyn.

In 1900 the engineering partnership was dissolved, after which, his health being broken, due largely to severe injuries received in a railroad accident, he did little active work for several years. In 1907 he entered the service of the New York State Engineering Department in a field position on the New Barge Canal. The active, outdoor work greatly improved his health, and gave him restored confidence and vigor. He received several promotions, being placed, after about two years' service, in charge of the execution of one of the contracts on the Oswego Canal, in the vicinity of his first engineering work. His early acquaintance with the locality, combined with his ability and experience, made him of great value to his employers in the settlement of water rights and similar problems involved in the construction of the new canal. It seems, indeed, a pity that this reawakened career of activity could not have been continued and crowned with still greater success. The all-wise Providence ruled otherwise, however. The injuries received in the railroad accident many years before (1892) were so serious that Mr. Thomson never fully recovered, and they finally caused his death, which occurred on February 7th, 1910, at his home in Syracuse, N. Y.

---

* Memoir prepared by A. W. Carpenter, M. Am. Soc. C. E.

During the later years of his service with the New York Central and Hudson River Railroad, and in his following consulting practice, Mr. Thomson gained great prominence as a bridge engineer. He continued the advocacy of riveted truss construction, which had been especially developed on the New York Central Railroad, and on that road, in 1888, he introduced the ballasted trough floor, this being its first use on American railways. This floor was in the form of rectangular troughs, and Mr. Thomson used it very extensively in the design of bridges on the New York Central, the St. Lawrence and Adirondack, the Mohawk and Malone, the Central Vermont, and the Rutland Railroads. He also developed a type of truss, known by his name, of which a number were built on the New York Central and other railroads and are still in service. This truss consists of a double Warren system, with subdivided panels and all connections riveted. He designed plate girders of lengths that must have seemed bold for their time, there being one span of 115 ft. 6 in., built in 1890 and still in service, and many built in the early Nineties were more than 100 ft. long.

Mr. Thomson was early in adopting steel as a substitute for iron in bridge construction; he examined very carefully into its manufacture, and prepared specifications for acid open-hearth steel for structural work, which were remarkable for their scope and thoroughness. They called for a grade of material which probably is not excelled by the best product of to-day. A prominent bridge engineer, who knew him and his work well, writes: "There were few bridges built in those times which had as good material in them as those which he put up."

The largest and most striking structures designed by Mr. Thomson or under his direction are the Park Avenue Viaduct and the Harlem River four-track draw-bridge of the New York Central and Hudson River Railroad in New York City. The former is a four-track elevated structure of plate girders with a ballasted trough floor, about 1¼ miles long, and the latter is probably the heaviest and perhaps the most important draw-span in the world, being 398 ft. long, carrying four tracks on a solid trough floor (not ballasted), containing 2 200 tons of steel, and controlling the traffic of the railroad company into its New York terminal.

Mr. Thomson, as before suggested, was a strong advocate of riveted *versus* pin-connected trusses, and he may be said to have been a violent opponent of the latter. He designed and built riveted lattice trusses up to 230 ft. span (single-track, Bridge No. 31, Central Vermont Railroad, Thomson-type trusses), advocated their construction to 250 ft. span, and is said to have designed a single-track riveted truss of 500 ft. span, which, however, was not built. Examples of his designs have been reproduced and commended in prominent textbooks on bridge design, and many were described and illustrated in the technical magazines of his time.

In his designing, Mr. Thomson gave a great deal of thought to the action of metal in bridge members under stress, "structural motion," as he called it, and he attempted to proportion bridge members with such action in view. He studied closely the action of bridges under live loads; he was not satisfied to follow the ordinary "strain sheet" practice, but sought to provide additional methods of gaining rigidity and permanence, accompanied with economy, in structures. Some of the important things he recognized in the early Nineties were the effect of time in loading members, and the unequal distortion of members of equal section but varying length.

In his "structural motion" theory, which was given considerable attention at one time, he recognized the distortion of members under stress as changing the conditions of static computations, and considered the effect of frequency of loading to be, even with moderate live loads, a leading factor, as well as the application of the maximum live load. Vibratory effects were also considered. This theory, which Mr. Thomson did not develop as clearly as might be desired, did not lead directly to any well-defined rules or specifications for designing of which there is any record, but it appears to have in it the elements of the present impact and secondary stress conceptions, which it probably assisted to develop. It shows, at least, Mr. Thomson's originality of thought, and his characteristic of searching deep below the surface.

Mr. Thomson was known and honored as a bridge engineer abroad as well as in his own country. His papers show that, in connection with the design and fabrication of the steel for the Forth Bridge, he was consulted by the late Sir Benjamin Baker, Hon. M. Am. Soc. C. E., with whom he contracted a warm friendship. In 1888 he visited England, and, at the request of Sir Benjamin Baker, read a paper before the British Association for the Advancement of Science, at Bath. This paper, entitled "Mechanical Pathology in its Relation to Bridge Design," attracted much attention, and was published in full, with illustrations, in *Engineering*, under the title "American Bridge Failures." It contains a great deal of valuable information in connection with the design of bridges, as derived from Mr. Thomson's long experience, and sets forth his principles of design. The latter are certainly in remarkably close agreement with the most approved practice of to-day, and show the advanced professional position of the man.

The engineering journals received many articles from Mr. Thomson's pen, and published many descriptions of his designs. Most of these are in the issues of the years 1888 to 1894, inclusive. His most recent contribution was a paper published in *Engineering News*, January 23d, 1908, entitled "Riveted Lattice for Railroad Bridges of Maximum Span: A Plea for a Return to Rational Design." He contributed freely to discussions of papers to this Society between 1887 and 1899, generally in connection with the design and construction of bridges.

Mr. Thomson was a man having a brilliant intellect, of the analytical type. He had a pleasing personality, and was a captivating conversationalist. His honesty was unquestioned. Frank and outspoken in his opinions, likes, and dislikes, he may have antagonized some, but he made many warm friends, and they were of the kind that stood by him through fortune and adversity. His wife, six daughters, and a son, the latter a Junior of this Society, survive him.

Mr. Thomson was elected a Member of the American Society of Civil Engineers on February 2d, 1887. He was also a Member of the British Institution of Civil Engineers, to which he was elected on May 7th, 1889, being one of the earliest American engineers to be thus honored.

VARDRY ECHOLS McBEE, Jr., Assoc. M. Am. Soc. C. E.*

DIED JUNE 20TH, 1910.

Vardry Echols McBee, Jr., was born in Charlotte, N. C., on November 24th, 1879. He was the only son of V. E. and Rosa (Brooks) McBee, of South Carolina.

Mr. McBee was graduated from the Virginia Military Institute in 1899, and immediately accepted service with the Seaboard Air Line Railway. He became prominent in the location and construction of this railroad throughout the South, especially on its extensions into Columbia, S. C., Birmingham, Ala., and in Florida.

While in charge of a locating party on the West Coast of Florida, Mr. McBee succumbed to an attack of paralysis, and after an illness of two weeks, he died in the hospital at Ocala, Fla., on June 20th, 1910.

---

* Memoir prepared by L. P. Slattery, Assoc. M. Am. Soc. C. E.

In 1907, Mr. McBee was married to Miss Marie Hudgins, of Alabama, who, with an infant daughter, his father, mother, and sister, is left to mourn his loss.

Although taken away at the early age of 30 years, Mr. McBee was recognized as a man of exceptional ability and high professional talent. By his death the Profession has lost a most promising railroad engineer, the country a good citizen, and his friends a friend indeed; but a loving soul has returned to the God that gave it.

Mr. McBee was elected an Associate Member of the American Society of Civil Engineers on October 7th, 1908.

RALPH CARROLL SOPER, Assoc. M. Am. Soc. C. E.*

DIED JUNE 16TH, 1910.

Ralph Carroll Soper was born on February 3d, 1881, at South Royalton, Vt., at which place his early education was obtained. He was graduated from Dartmouth College with the degree of A. B. in 1902, and from the Thayer School of Engineering with the degree of C. E. in 1904.

Mr. Soper began his professional career with the Illinois Steel Company, where he was employed until May, 1905.

On May 1st, 1905, Mr. Soper was appointed as Engineering Aid in the United States Reclamation Service, and assigned to work on the preliminary surveys of the Shoshone Project, Wyoming. On May 1st, 1907, he was advanced to the grade of Assistant Engineer, and assigned to work on the Corbett Tunnel, Shoshone Project, which position he filled until the completion of the tunnel in 1907. He afterward held various responsible assignments on the Flathead and Shoshone Projects and in the office of the Supervising Engineer.

On the evening of June 16th, 1910, while on a pleasure trip in a motor-boat on the Shoshone Reservoir, near Cody, Wyo., with four other employees of the Reclamation Service, the boat unfortunately upset, and Mr. Soper and three of his companions were drowned.

Mr. Soper was possessed of many sterling qualities, and commanded the respect of his associates and those under and over him in authority. His work at all times showed great possibilities for his ultimate success, ,and his loss will be much regretted by the Service, from a professional standpoint, and particularly by the numerous friends and acquaintances which his pleasing personality and good nature had made for him in his work.

Mr. Soper was elected an Associate Member of the American Society of Civil Engineers on August 31st, 1909.

---

* Memoir prepared by H. N. Savage, M. Am. Soc. C. E.

William P. Morse

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XXXVI—No. 8

AMERICAN
SOCIETY OF
CIVIL
ENGINEERS
FOUNDED
1852

PRESENTED TO
[illegible] CIVIL
ENGINEERING SOCIETY
BY
WILLIAM P. MORSE

October, 1910

Published at the House of the Society, 220 West Fifty-seventh Street, New York,
the Fourth Wednesday of each Month, except June and July.

Copyrighted 1910, by the American Society of Civil Engineers.
Entered as Second-Class Matter at the New York City Post Office, December 15th, 1906.
Subscription, $8 per annum.

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XXXVI—No. 8

OCTOBER, 1910

Edited by the Secretary, under the direction of the Committee on Publications.

Reprints from this publication, which is copyrighted, may be made on condition that the full title of Paper, name of Author, page reference, and date of presentation to the Society, are given.

CONTENTS

Society Affairs..........................Pages 445 to 486.
Papers and Discussions................Pages 1243 to 1318.

NEW YORK 1910.

Entered according to Act of Congress, in the year 1910, by the AMERICAN SOCIETY OF CIVIL ENGINEERS, in the office of the Librarian of Congress, at Washington.

American Society of Civil Engineers

OFFICERS FOR 1910

President, JOHN A. BENSEL

Vice-Presidents

Term expires January, 1911:
GEORGE H. PEGRAM
EMIL SWENSSON

Term expires January, 1912:
JOHN T. FANNING
HUNTER McDONALD

Secretary, CHARLES WARREN HUNT

Treasurer, JOSEPH M. KNAP

Directors

Term expires January, 1911:
CHARLES L. HARRISON
GEORGE W. KITTREDGE
DEXTER BRACKETT
HORACE ANDREWS
GARDNER S. WILLIAMS
CHARLES S. CHURCHILL

Term expires January, 1912:
FRANCIS LEE STUART
SAMUEL C. THOMPSON
WILLIAM G. WILKINS
ARTHUR N. TALBOT
WILLIAM M. GARDNER
HORACE A. SUMNER

Term expires January, 1913:
WILLIAM E. BELKNAP
HORACE LOOMIS
GEORGE A. KIMBALL
PERCIVAL ROBERTS, Jr.
CHARLES F. LOWETH
ARTHUR DeWINT FOOTE

Assistant Secretary, T. J. McMINN

Standing Committees

(The President of the Society is *ex-officio* Member of all Committees)

On Finance:
GEORGE H. PEGRAM
CHARLES S. CHURCHILL
GEORGE A. KIMBALL
HORACE LOOMIS
WILLIAM G. WILKINS

On Publications:
C. L. HARRISON
HORACE ANDREWS
WILLIAM E. BELKNAP
FRANCIS LEE STUART
EMIL SWENSSON

On Library:
GEORGE W. KITTREDGE
DEXTER BRACKETT
JOHN T. FANNING
HUNTER McDONALD
CHAS. WARREN HUNT

Special Committees

On Uniform Tests of Cement: George S. Webster, Richard L. Humphrey, George F. Swain, Alfred Noble, Louis C. Sabin, S. B. Newberry, Clifford Richardson, W. B. W. Howe, F. H. Lewis.

On Concrete and Reinforced Concrete: C. C. Schneider, J. E. Greiner, W. K. Hatt, Olaf Hoff, Richard L. Humphrey, Robert W. Lesley, Emil Swensson, A. N. Talbot, Joseph R. Worcester.

On Engineering Education: Desmond FitzGerald, Benjamin M. Harrod, Onward Bates, D. W. Mead, Charles Hansel.

On Steel Columns and Struts: Austin L. Bowman, Alfred P. Boller, Emil Gerber, Charles F. Loweth, Ralph Modjeski, Frank C. Osborn, George H. Pegram, Lewis D. Rights, George F. Swain, Emil Swensson, Joseph R. Worcester.

On Bituminous Materials for Road Construction: W. W. Crosby, A. W. Dean, H. K. Bishop, A. H. Blanchard.

◆

The House of the Society is open from 9 a. m. to 10 p. m. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

House of the Society—220 West Fifty-seventh Street, New York.

Telephone Number.................5913 Columbus.
Cable Address..................."Ceas, New York."

Vol. XXXVI. OCTOBER, 1910. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

SOCIETY AFFAIRS

CONTENTS

Minutes of Meetings: PAGE
Of the Society, September 21st and October 5th, 1910 445
Of the Board of Direction, October 4th, 1910 448
Announcements:
Hours during which the Society House is open 449
Future Meetings 449
Special Meetings for Topical Discussion 449
List of Nominees for Offices to be filled January 18th, 1911 450
The John Fritz Medal 451
Searches in the Library 452
Papers and Discussions 452
Subscription Price to the Publications of the Society 453
Local Associations of Members of the American Society of Civil Engineers 453
Privileges of Engineering Societies Extended to Members 454
Accessions to the Library:
Donations 456
By purchase 460
Membership (Additions, Changes of Address, Resignations, Deaths) 461
Recent Engineering Articles of Interest 471

MINUTES OF MEETINGS

OF THE SOCIETY

September 21st, 1910.—The meeting was called to order at 8.30 P. M.; Director Samuel C. Thompson in the chair; Chas. Warren Hunt, Secretary; and present, also, 192 members and 37 guests.

Three papers on the New York Tunnel Extension of the Pennsylvania Railroad were presented and illustrated with lantern slides, as follows: "The Long Island Approaches to the East River Tunnels," by George C. Clarke, M. Am. Soc. C. E., "The Lining of the Four Permanent Shafts of the East River Division," by F. M. Green, Assoc. M. Am. Soc. C. E., which were presented by the authors, and "The Sunnyside Yard," by Louis H. Barker, Esq., which was presented by H. W. Hudson, Assoc. M. Am. Soc. C. E.

Adjourned.

October 5th, 1910.—The meeting was called to order at 8.30 P. M.; A. L. Bowman, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 109 members and 16 guests.

The minutes of the meeting of September 7th, 1910, were approved as printed in *Proceedings* for September, 1910.

A paper by E. G. Hopson, M. Am. Soc. C. E., entitled "The Tieton Canal," was presented by the Secretary, who also read a communication on the subject by Horace W. Sheley, Assoc. M. Am. Soc. C. E.

The Secretary announced the election of the following candidates by the Board of Direction on October 4th, 1910:

As Members.

Harry William Baum, Denver, Colo.
Frank Dudley Brown, Shawnee, Okla.
Robert Dunn Budd, Petersburg, Va.
Frank Hearne Crockard, Birmingham, Ala.
James Lee Darnell, Kansas City, Mo.
David Augustus Decrow, Buffalo, N. Y.
James Edward Fulton, Wellington, New Zealand.
William Burr Gester, San Francisco, Cal.
Robert Arthur Greenfield, New York City.
Andrew Christian Hansen, Craft, Cal.
Ricardo Tomás Jordán, Rincon Antonio, Oax., Mexico.
William Frederick Lockwood, New York City.
Archy Magill Nelson, Salt Lake City, Utah.
John Orr, Johannesburg, South Africa.
Walter Frederick Schulz, Memphis, Tenn.
George Harry Thornton Shaw, Toluca, Mex., Mexico.
Horton Whitefield Stickle, Gatun, Canal Zone, Panama.

As Associate Members.

William Franklin Allison, Golden, Colo.
Floyd Dwight Angel, Phœnix, Ariz.
Seymour Dewey Brown, Paris, France.
Stephen Sans Bunker, Manãos, Brazil.
Adam Leonard Bush, Los Angeles, Cal.
Dean Orrice Carr, Birmingham, Ala.
Arthur Edward Clark, Brooklyn, N. Y.
Robert Coltman, 3d, Lachine Locks, Que., Canada.
Bruce Lincoln Cushing, Firmeza, Cuba.
Clarence Derrick, Culebra, Canal Zone, Panama.
Teiji Ebashi, Kansas City, Mo.
Paul David Fuqua, Montgomery, Ala.

William Hague, Bisbee, Ariz.
William Henry Hall, New Britain, Conn.
Donald Symington Hays, Victoria, B. C., Canada.
Kearney Everett Hendricks, South Bethlehem, Pa.
Leroy Lemayne Hidinger, Washington, D. C.
William Paul Hufschmidt, St. Louis, Mo.
Merton Earle James, Amsterdam, N. Y.
Natt Madison Johnson, Gatun, Canal Zone, Panama.
John Thomas Land, Norfolk, Va.
Richard Herbert Martin, St. Augustine, Fla.
James Lawrence Meem, Lynchburg, Va.
Thomas Jefferson Palm, San Saba, Tex.
Maurice Vernon Powell, Columbia, Mo.
Jackson Letton Richmond, Evansville, Ind.
George Wilhelm, Oakland, Cal.
Harry Williamson, Bahia Blanca, Argentine Republic.

As Associate.

Ramaswamier Panchanadam Iyer, Hindupur, Deccan, India.

As Juniors.

Murray James Backus, Ensenada, Porto Rico.
Isadore Behrman, Baltimore, Md.
Shanker Ramchandra Bhagwat, Poona City, India.
Walter Augustus Buell, Flushing, N. Y.
Henry Hart Cartwright, Louisville, Ky.
Royal William Davenport, Worcester, Mass.
Henry Charles Frisbie, Boston, Mass.
Clifford Willard Gaylord, Des Moines, Iowa.
Samuel Gordon, Mare Island, Cal.
John William Graham, Cebu, Philippine Islands.
George Frederick Maglott, Boston, Mass.
Hope Richard Messer, Roanoke, Va.
Daniel Willets Overocker, Amsterdam, N. Y.
Asa Glisson Proctor, Woodland, Cal.
Leon Benedict Reynolds, Kansas City, Mo.
Russell Alva See, New Florence, Mo.
William Durkee Smith, The Dalles, Ore.
Lloyd Isadore Smoyer, New York City.
Harry Seel Stanton, El Paso, Tex.
Taoyuh Clarance Sun, Shanghai, China.
Howard Thomas Ware, Brewerton, N. Y.

The Secretary announced the transfer of the following candidates by the Board of Direction on October 4th, 1910:

FROM ASSOCIATE MEMBER TO MEMBER.

NEWTON FISHER HOPKINS, Pittsburg, Pa.
ERNEST JAMES THEODORE MANCHESTER, Brisbane, Australia.
FREDERICK CLINTON PHILLIPS, Jacksonville, Fla.
THOMAS DORSEY PITTS, Baltimore, Md.

FROM JUNIOR TO MEMBER.

EDMUND MOORE RHETT, Savannah, Ga.

FROM JUNIOR TO ASSOCIATE MEMBER.

CHESTER SALISBURY ALLEN, Boston, Mass.
ARTHUR BONIFACE, New York City.
RALPH HANEY BURKE, Chicago, Ill.
JOHN HARRISON FOSS, Palo Alto, Cal.
WINFIELD HOLBROOK, Penrose, Colo.
EDWIN BENJAMIN KARNOPP, Cristobal, Canal Zone, Panama.
FRANK CECIL MAGRUDER, Orman, S. Dak.
ALBIN GEORG NICOLAYSEN, Elizabeth, N. J.
AUGUSTUS TABER PARSONS, Bakersfield, Cal.
JOHN CHARLES PRITCHARD, St. Louis, Mo.
ERNEST FRANKLIN ROBINSON, New York City.
GEORGE NOBLE TOOPS, Pocatello, Idaho.

FROM JUNIOR TO ASSOCIATE.

ALVIN LEROY GILMORE, New York City.

Adjourned.

OF THE BOARD OF DIRECTION

(Abstract)

October 4th, 1910.—President Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Belknap, Brackett, Kittredge, Knap, Loomis, Loweth, Macdonald, Pegram, Schneider, Stearns, Swensson, Thompson, and Wilkins.

Three Corporate Members of the Society from each State of the Union were appointed, in accordance with the action of the Business Meeting of the Annual Convention, to co-operate with the Board of Direction in the matter of any proposed legislation affecting the practice of Civil Engineers.

Ballots for membership were canvassed resulting in the election of 17 Members, 28 Associate Members, 1 Associate, and 21 Juniors, and the transfer of 1 Junior to the grade of Member, 12 Juniors to the grade of Associate Member, and 1 Junior to the grade of Associate.

Four Associate Members were transferred to the grade of Member.

Applications were considered and other routine business transacted.

Adjourned.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

November 2d, 1910.—8.30 P. M.—At this meeting a paper entitled "The Arch Principle in Engineering and Esthetic Aspects, and its Application to Long Spans," by C. R. Grimm, M. Am. Soc. C. E., will be presented for discussion.

This paper was printed in *Proceedings* for September, 1910.

November 16th, 1910.—8.30 P. M.—A paper by H. H. Wadsworth, M. Am. Soc. C. E., entitled "The Failure of the Yuba River Débris Barrier, and the Efforts Made for its Maintenance," will be presented for discussion.

This paper was printed in *Proceedings* for September, 1910.

December 7th, 1910.—8.30 P. M.—At this meeting a paper entitled "Bond-Friction-Resistance in Reinforced Concrete," by William Fry Scott, Assoc. M. Am. Soc. C. E., will be presented for discussion.

This paper is printed in this number of *Proceedings.*

SPECIAL MEETINGS FOR TOPICAL DISCUSSION

Preliminary notice is hereby given that on Friday and Saturday, January 20th and 21st, 1911 (the days following the close of the Annual Meeting of the Society), three meetings of the Society will be held, the first on the morning of Friday, January 20th, 1911, the second on the afternoon of that day, and the third on the morning of Saturday, January 21st, 1911.

At these meetings the general subject for topical discussion and its subdivisions, which will be taken up separately, are:

"Road Construction and Maintenance."

(1) Preliminary Investigations.
(2) Relative Value of Three Methods of Carrying on Work:
    (*a*) That in which both labor and material are furnished by the contractor.
    (*b*) That in which the material is supplied by the party of the first part, and the labor by the contractor.
    (*c*) That in which both the labor and material are supplied by the party of the first part.
(3) Systems of Maintenance.
(4) The Use of Water, Calcium Chloride, Light Oils, etc., as Dust Palliatives.

(5) Surface Treatment with Tars, Heavy Oils, etc.
(6) The Use of Bituminous Materials by Penetration Methods.
(7) The Use of Bituminous Materials by Mixing Methods.

The discussion on each of the above topics will be presented by an engineer specially selected for that purpose, and such presentation will be limited to ten minutes; the discussion of each of the subsequent speakers will be limited to five-minute talks, in order that everyone interested may have an opportunity to give his views, and that the resulting discussion, when edited and collated, under the rules of the Society, for publication, may be a concise summary of present-day practice.

All engineers interested in road building, whether members of the Society or not, are invited to be present and take part in this discussion.

The hours for holding the meetings, names of speakers, etc., will be given in a subsequent notice.

LIST OF NOMINEES FOR THE OFFICES TO BE FILLED AT THE ANNUAL ELECTION, JANUARY 18th, 1911

The following list of nominees for the offices to be filled at the Annual Meeting, January 18th, 1911, received from the Nominating Committee, was presented to the Board of Direction at its meeting on September 6th, 1910. The list has already been mailed to all Corporate Members:

For President, to serve one year:

Mordecai T. Endicott, Washington, D. C.

For Vice-Presidents, to serve two years:

Alfred P. Boller, New York City.
Charles L. Strobel, Chicago, Ill.

For Treasurer, to serve one year:

Joseph M. Knap, New York City.

For Directors, to serve three years:

George C. Clarke, New York City	District No. 1
Henry G. Stott, New Rochelle, N. Y.	District No. 1
Jonathan P. Snow, Boston, Mass.	District No. 2
Robert Ridgway, Poughkeepsie, N. Y.	District No. 3
Leonard W. Rundlett, St. Paul, Minn.	District No. 3
William H. Courtenay, Louisville, Ky.	District No. 6

THE JOHN FRITZ MEDAL

PUBLIC MEETING FOR THE PRESENTATION OF THE MEDAL FOR 1910

The John Fritz Medal was established by the professional associates and friends of John Fritz, Hon. M. Am. Soc. C. E., of Bethlehem, Pa., on August 21st, 1902, his eightieth birthday, to perpetuate the memory of his achievements in industrial progress. The Medal is awarded by a Board of sixteen, made up in equal numbers from the membership of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. It is awarded for notable scientific or industrial achievement, and there is no restriction on account of nationality or sex.

Awards of this medal to date have been made as follows:

The first (1905) to **Lord Kelvin** "for his Work in Cable Telegraphy and other Scientific Attainments."

The second (1906) to **George Westinghouse** "for the Invention and Development of the Air Brake."

The third (1907) to **Alexander Graham Bell** "for the Invention and Introduction of the Telephone."

The fourth (1908) to **Thomas Alva Edison** "for the Invention of the Duplex and Quadruplex Telegraph; the Phonograph; the Development of a Commercially Practical Incandescent Lamp; the Development of a Complete System of Electric Lighting, Including Dynamos, Regulating Devices, Underground System Protective Devices and Meters."

The fifth (1909) to **Charles T. Porter** "for his Work in Advancing the Knowledge of Steam Engineering and in Improvements in Engine Construction."

The Medal for 1910 has been awarded to **Alfred Noble,** Past-President, Am. Soc. C. E., "for Notable Achievements as a Civil Engineer," and will be presented at a meeting to be held at the House of the American Society of Civil Engineers on the evening of Wednesday, November 30th, 1910, at 8.30 P. M. All members of the four National Societies above named, and all others interested, are invited to be present.

Dr. Samuel Sheldon, Past-President, Am. Inst. of Elec. Engrs., now President of the Board of Award, will preside, and addresses will be made by Isham Randolph, M. Am. Soc. C. E., of Chicago, Rossiter W. Raymond, Secretary of the American Institute of Mining Engineers, and others.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendix* to the Annual Report of the Board of Direction for the year ending December 31st, 1906, contains a summary of all searches made to that date.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussion of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings.* The issue of volumes of *Transactions* is dependent on the closing of discussions, and the co-operation of the membership in this matter is essential to the regular issue of each quarterly volume.

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussion, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

---

* *Proceedings*, Vol. XXXIII, p. 20 (January, 1907).

SUBSCRIPTION PRICE TO THE PUBLICATIONS OF THE SOCIETY

The following subscription rates have been fixed by the Board of Direction for the publications of the Society:

Proceedings, ten Numbers per annum, $8. Price for single numbers, $1.

Transactions, four Volumes per annum, $12. Price for single volumes, $4.

On the above prices there is a discount of 25% to members who desire extra copies of any of these publications, to Libraries, and to Book-dealers.

There is also an additional charge per annum, to cover foreign postage, of 75 cents for *Proceedings* and $1 for *Transactions,* or 8 cents and 25 cents, respectively, for single numbers.

A special subscription rate has been fixed by the Board for the *Proceedings* of the Society for the benefit of Students in Technical Schools. This rate is $4.50 per annum, and is available to any *bona fide* student of any technical school.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Friday of February, April, June, August, October, and November, and also on the third Wednesday of December, the latter being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., Assoc. M. Am. Soc. C. E., 623 Wells Fargo Building.

The by-laws of the Association provide for the extension of hospitality to any members of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest of the Association at any of the above meetings, if he will notify the Secretary that he is in San Francisco.

Colorado Association

(Abstract of Minutes of Meeting)

September 10th, 1910.—The meeting was called to order about 8.30 P. M.; President Anderson in the chair; H. J. Burt, Secretary; and present, also, 17 members and 8 guests.

The meeting was devoted to a discussion of the proposed bill for the Licensing of Civil Engineers. President Anderson, acting as Chairman of the Committee on Legislation, presented a preliminary draft of the proposed bill. A general discussion of the subject followed, but no definite action was taken. The Committee expects to present a revised draft of the bill at a later meeting.

Adjourned.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

Architekten=Verein zu Berlin, Wilhelmstrasse 92, Berlin W. 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, 718 Caxton Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Colorado Association of Members, Am. Soc. C. E., H. J. Burt, Secy., 235 Equitable Building, Denver, Colo.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 803 Fulton Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur= und Architekten=Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur= und Architekten=Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE LIBRARY

(From September 13th to October 10th, 1910)

DONATIONS*

THE CONSTRUCTION OF GRAPHICAL CHARTS.

By John B. Peddle. Cloth, 9½ x 6 in., illus., 8 + 109 pp. New York and London, McGraw-Hill Book Company, 1910. $1.50.

Little has been written in English, the author states, on the subject of nomography, except a few magazine articles, and it is with the hope of supplying this deficiency that he has issued this, the first American, book on the subject. The subject-matter originally appeared in serial form in the *American Machinist*. The calculating chart, or nomogram, is a device for performing expeditiously the work of calculation for the engineer or designer, leading to a saving of time and to minimizing the chances of error. In order to make the instrument useful an engineer should be sufficiently acquainted with the underlying principles of its construction to adapt it to his individual needs, and the author states that it has been his aim to make these principles clear. The mathematical treatment has been simplified, instead of a purely theoretical analysis of the methods used, a series of illustrative problems have been worked out in detail for nearly all the chart forms described, and the charts are applied only to the simpler forms of equations. It is also stated that "the processes described here, if thoroughly understood, should be sufficient to cover a large proportion of the formulas in common use." The Chapter Headings are: Charts Plotted on Rectangular Coordinates; The Alinement Chart; Alinement Charts for More than Three Variables; The Hexagonal Index Chart; Proportional Charts; Empirical Equations; Stereographic Charts and Solid Models.

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS.

Written and Compiled by a Staff of Specialists. Third Edition, Revised and Enlarged. Morocco, 7 x 4 in., illus., 11 + 1 497 pp. New York and London, McGraw-Hill Book Company, 1910. $4.00.

It is stated that this edition of this work has been thoroughly revised and greatly enlarged, 200 pages of new matter having been added and many new reference tables included, and that about 40% of the subject-matter is entirely new. It is said to cover the entire field of electrical engineering and to contain much data that will be of interest and help to consulting, contracting, and designing engineers. The subject-matter is divided into twenty sections or units, each of which has been written by a specialist. Recognized standards, especially those recommended by National societies or organizations, have been followed wherever possible. Section 19 contains the Standardization Report of the American Institute of Electrical Engineers for 1910, the Specifications for Copper Wire of the American Society for Testing Materials, the Specifications for Rubber Insulation of the Rubber Covered Wire Engineers, the Standard Axles, Journals, and Brakes of the American Street and Interurban Railway Engineering Association, etc. In the Index all references are made to section and paragraph, the latter being numbered from one to the end. Cross references are also made in the Index to all other parts of the book where that subject may be treated. The Contents are: Units, by Otis Allen Kenyon; Electric, Magnetic and Dielectric Circuits, by Otis Allen Kenyon; Measurements and Measuring Apparatus, by Otis Allen Kenyon; Properties of Materials, by Otis Allen Kenyon; Magnets, Resistors, Condensors, and Reactors, by Otis Allen Kenyon; Transformers and Converters, by A. S. McAllister; Electric Generators, by H. M. Hobart and Otis Allen Kenyon; Electric Motors, by A. S. McAllister; Batteries, by Edward Lyndon and Otis Allen Kenyon; Central Stations, by R. C. Beardsley and George C. Shaad; Transmission and Distribution, by Arthur Vaughan Abbott and Otis Allen Kenyon; Illumination, by Louis Bell; Electric Traction, by A. H. Armstrong; Electrochemistry, by E. F. Roeber; Telephony, by Kempster B. Miller; Telegraphy, by Otis Allen Kenyon; Miscellaneous Applications, by Otis Allen Kenyon; Wiring, by William H. Onken; Standardization Rules; Tables and Statistics; Index.

CONTRACTS IN ENGINEERING.

The Interpretation and Writing of Engineering-Commercial Agreements. By James Irwin Tucker. Cloth, 9 x 6 in., 12 + 307 pp. New York and London, McGraw-Hill Book Company, 1910. $3.00.

The chief aim of this book, as set forth in the preface, is to familiarize engineering students with the major principles of common law relating to Contracts.

---

* Unless otherwise specified, books in this list have been donated by the publishers.

other legal branches being included only in so far as they apply to the doctrines of contract law. About one-third of the book, therefore, relates to commercial contracts, the remainder dealing with elementary principles common to all contracts, namely, stocks, bonds, notes, sales, the law of property in general, of agency, tort, the formation of partnerships, and of the powers and functions of corporation officials. The author, as Assistant Professor in Civil Engineering, at Tufts College, prepared much of the present material as a course in Contracts and Specifications, and he hopes that it will prove a textbook suitable in form and subject-matter for use in engineering schools. Appendix Notes are given to outline topics where too many details and correlated ideas have developed, and bold face type, numbered section titles, italics, and a comprehensive index, make the book valuable for reference. Analytical diagrams of the chapters and lists of quiz questions and problems are given at the end of each chapter. The Contents are: Introduction; Contract Essentials; Development of Contract Principles; Agency, Tort, and Independent Contractor; Real Property; Contracts of Association—Corporations; Contracts of Sale and Transportation; Negotiable Paper; Preparing and Writing Engineering Contracts; Appendix Notes; Index.

STANDARD SPECIFICATIONS.

For Structural Steel—Timber—Concrete and Reinforced Concrete. By John C. Ostrup, M. Am. Soc. C. E. Cloth, 9½ x 6½ in., illus., 8 + 99 pp. New York and London, McGraw-Hill Book Company, 1910. $1.00.

A set of ten specifications is contained in this book and is intended to suit equally the needs of engineers, architects, contractors, teachers, and students. These specifications are stated by the author to cover the most important materials used in construction work of any magnitude and to be so condensed as to avoid unnecessary repetition. They are said to be consistent and to conform in every essential to the latest experiments and investigations, to the best authorities, to modern practice, and to the author's experiences. Particular attention is called to the specifications for reinforced concrete, as being rather extensive and probably the first complete set in existence. The subject-matter relating to each specification is arranged as nearly as possible in the order in which the information will be required. The Chapter Headings are: Steel Framework of Buildings; Highway Bridges; Railroad Bridges; Plate Girders; Materials and Workmanship; Inspection, Painting and Erection; Structural Timber; Cement; Portland-Cement Concrete; Reinforced Concrete; Index.

DUST PREVENTIVES AND ROAD BINDERS.

By Prévost Hubbard. Cloth, 9 x 6 in., illus., 7 + 416 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1910. $3.00.

The subject of dust prevention and road preservation is stated by the author to be at present in a transitional state, and that much is yet to be learned of the effect of certain properties of road binders on the results obtained in practice. It has been his aim in this book to furnish road engineers with a working knowledge of the properties of the dust preventives and road binders now in use and to develop certain fundamental principles relative to their selection and application. As Chemist in the United States Office of Public Roads during the past five years, the author has supervised the examination of practically all the different road binders and their use under varying conditions in many parts of the country, and the conclusions presented herein are based on his experiences in the laboratory and in the field. The Contents are: Dust Prevention and Road Preservation; Classification of Dust Preventives and Road Binders; Inorganic Dust Preventives and Road Binders; Organic Non-Bituminous Dust Preventives and Road Binders; Hydrocarbons; Bitumens Employed as Dust Preventives and Road Binders; Petroleum and Petroleum Products; Semi-Solid and Solid Native Bitumens; Application of Petroleum and Asphaltic Materials; Tars and Tar Products; The Application of Tar and Construction of Bituminous Macadam; The Examination of Bituminous Road Materials and Interpretation of Results; Methods of Testing Bituminous Road Materials Proposed or Adopted by American Societies; Selection of Dust Preventives and Road Binders; Appendix.

SEWAGE DISPOSAL.

By Leonard P. Kinnicutt, C.-E. A. Winslow, and R. Winthrop Pratt. Cloth, 9 x 6 in., illus., 26 + 436 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1910. $3.00.

In this volume is given, it is stated, a general survey of the problem of sewage disposal as viewed from the standpoint of the chemist, the sanitary biologist, and the engineer, with particular reference to American practice. It has been the aim of the authors to discuss the fundamental principles of chemistry and bacteriology involved somewhat fully, and to include also the more important aspects of the engineering works designed for their operation. It is hoped that the book may prove useful not only to the student of sanitary engineering, but also to the engineer, the chemist, the bacteriologist, and the public health official concerned in the construction and operation of sewage disposal plants. The Chapter Headings are: The Sanitary Demand for Sewerage and Sewage Disposal; Composition of Sewage; Disposal of Sewage by Dilution, Screening and Straining of Sewage; Primary Treatment of Sewage by Sedimentation; Preliminary Treatment of Sewage by Chemical Precipitation; Preliminary Treatment of Sewage by the Septic Process; Disposal of Sewage Sludge; Purification of Sewage by Broad Irrigation and Sewage Farming; Purification of Sewage by Intermittent Filtration Through Sand; Purification of Sewage in Contact Beds; Purification of Sewage on Trickling or Percolating Beds; Disinfection of Sewage and Sewage Effluents; Analysis of Sewage and Sewage Effluents; References; Indexes.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES

For Buyers and Sellers. Nineteenth Annual Edition. Cloth, 10½ x 7½ in., illus., 100 + 1 342 pp. New York, Samuel E. Hendricks Co., 1910. $10.00.

This publication is stated to be especially devoted to the interests of the architectural, mechanical, engineering, contracting, electrical, railroad, iron, steel, hardware, mining, mill, quarrying, exporting, and kindred industries, being a complete annual index containing business classifications and the names and addresses of manufacturers of and dealers in everything used in the manufacture of material, machinery, and apparatus for these vast industries. The contents are classified by subject, under which are given, in alphabetical order and, in some cases, by States, the names and addresses of firms dealing in that particular article. An alphabetical list of advertisers and the addresses of their branches, is included. There is an index of 100 pages.

DEUTSCHER AUSSCHUSS FÜR EISENBETON.

Bericht des Königlichen Materialprüfungsamtes zu Gross-Lichterfelde-West über die Ihm Uebertragenen Versuche mit Eisenbeton, Säulen, Reihe I und II. Erstattet von Professor M. Rudeloff. Paper, 11 x 7 in., illus., 118 pp. Berlin, Wilhelm Ernst & Sohn, 1910. 6 Marks.

This work embodies the report of the German Committee on Reinforced Concrete, of tests on reinforced concrete columns. These tests were made to determine the influence of various cross and longitudinal forms of reinforcement, and covered the years from 1907 to 1909. The report is divided into two parts, or series, namely, Preliminary Tests and Supplementary Tests, and it is stated that it contains descriptions of the best forms of cross reinforcement to be used in reinforced concrete columns. All the columns tested were made of the same concrete, and they were arranged as they would appear in actual practice. Three similar tests were made for each series with the same form of reinforcement. The arrangement of the subject-matter in each part is as follows: Specifications of materials, materials used, methods of actual construction, testing the concrete, and tests of the columns, under which latter the apparatus used for measuring the change of forms, the results of the tests, and the conclusions reached, are discussed. The Contents are: Vorversuche (Reihe I): Bauart der Versuchskörper; Die verwendeten Baustoffe; Herstellung der Säulen; Prüfung des Betons; Festigkeitsversuche mit den Säulen. Ergänzungsversuche (Reihe II): Arbeitsplan; Die verwendeten Baustoffe; Herstellung der Säulen; Prüfung des Betons; Festigkeitsversuche mit den Säulen; Veränderungen in der Zusammensetzung und der Dichte des Betons beim Stampfen der Säulen; Anlagen.

THE EARNING POWER OF RAILROADS, 1910.

Compiled and Edited by Floyd W. Mundy. Cloth, 7½ x 5 in., 461 pp. New York and Chicago, Jas. H. Oliphant & Co., 1910. $2.50.

This volume contains, it is stated, important statistics relating to the earning power and to the securities of practically all the railroads in the United States, Canada, and Mexico. After the Introductory Chapters which explain in a general way the fundamental principles to be applied in ascertaining the value of the stocks or bonds of any railroad, Tables are given, which show the range of earnings of the railroads over a series of years, their mileage, capitalization, tonnage, income accounts, etc. These Tables are arranged so as to permit of easy comparison between those of each road. The Tables are followed by Notes which contain information regarding the capitalization, investments, physical and financial condition, etc., of the various roads, and which are to be used to supplement the facts given in the Tables. In preparing this book, it is stated that the official annual reports of railroads have been used, and those of 140 railroads have been reviewed. The Contents are: Index; Income Account; Operating Expenses; Maintenance Expenses; Maintenance of Way; Maintenance of Equipment; Traffic Transportation and General Expenses; The Operating Ratio; Fixed Charges; Stock Outstanding in Its Relation to Earning Power; Guarantees and Their Relation to Surplus Available for Dividends; Tables; Notes.

Gifts have also been received from the following:

Alaska Treadwell Gold Min. Co. 2 pam.
Architekten-Verein zu Berlin. 1 pam.
Assoc. Française du Froid. 1 pam.
Assoc. of Ry. Telegraph Supts. 1 pam.
Augusta, Ga.-City Council. 1 pam.
Boston & Maine R. R. Co. 1 pam.
Brit. Fire Prevention Committee. 1 bound vol.
Cambridge, Mass.-Mayor. 1 bound vol.
Canada-Dept. of Marine and Fisheries. 1 pam.
Cape of Good Hope-Gen. Mgr. of Rys. 8 vol., 1 bound vol.
Carnegie Steel Co. 2 pam.
Chicago & North Western Ry. Co. 1 pam.
Chicago, Indianapolis & Louisville Ry. Co. 1 pam.
Chicago, Milwaukee & St. Paul R. R. Co. 4 pam.
Chicago, St. Paul, Minneapolis & Omaha Ry. Co. 1 pam.
Colorado-Geol. Survey. 1 bound vol.
Colo. Scientific Soc. 1 pam.
Conn.-Saybrook and Lyme, Conn., River Bridge Comm. 1 pam.
Creuzbaur, R. Walter. 1 bound vol.
Engrs.' Club of Philadelphia. 1 bound vol.
Engrs.' Soc. of St. Paul. 1 pam.
France-Ministère des Travaux Publics, des Postes et des Telegraphes. 3 pam.
Georgia-Geol. Survey. 15 bound vol., 5 pam.
Gilbreth, Frank B. 1 pam.
Glasgow & South-Western Ry. Co. 1 pam.
Hampstead, England-Borough Engr. and Surv. 1 pam.
Hartford, Conn.-City Engr. 2 pam.
Highland Ry. Co. 1 pam.
Hocking Valley Ry. Co. 1 pam.
Houston, John J. 8 bound vol.
Hyde, Charles G. 1 pam.
Illinois, Univ. of-Agri. Exper. Station. 1 bound vol.
Institution of Naval Archts. 1 bound vol.
Inter. Peat Eng. Co. 1 pam.
Iron and Steel Inst. 1 bound vol., 1 pam.
Lake Mohonk Conference on Inter. Arbitration. 1 pam.
London, England-City Engr. 1 pam.
McGill Coll. 1 bound vol.
Madras, India-Public Works Dept. 1 pam.
Maine Central R. R. Co. 1 pam.
Michigan-State Board of Health. 9 pam.
Min. Soc. of Nova Scotia. 1 pam.
Minneapolis, St. Paul & Sault Ste. Marie Ry. Co. 1 pam.
Mississippi-Geol. Survey. 1 pam.
Missouri-Bureau of Labor Statistics. 1 pam.
Nashville, Chattanooga & St. Louis Ry. Co. 1 pam.
National Board of Fire Underwriters. 7 pam.
New Jersey-Geol. Survey. 1 pam.
New Mexico-Territorial Engr. 3 pam.
New South Wales-Chf. Commr. for Railways and Tramways. 1 pam.
New York State-Public Service Comm., Second Dist. 1 pam.
New York City Record. 1 bound vol.
New York, New Haven & Hartford R. R. Co. 1 pam.
New York, Ontario & Western Ry. Co. 1 pam.
Norfolk & Western Ry. Co. 1 pam.
North Brit. Ry. Co. 1 pam.
North-East Coast Institution of Engrs. and Shipbuilders. 1 bound vol.
Ohio Soc. of Mech., Elec. and Steam Engrs. 1 pam.
Oliphant, Jas. H., & Co. 2 pam., 1 bound vol.
Philadelphia Rapid Transit Co. 1 pam.
Philippine Islands-Bureau of Health. 1 pam.
Philippine Islands-Bureau of Sci. 1 pam.
Philippine Islands-Weather Bureau. 4 pam.
Poor's R. R. Manual Co. 1 bound vol.
Providence, R. I.-City Engr. 1 pam.
Providence, R. I.-Dept. of Public Works. 1 pam.
Reading Co. 1 pam.
Richards, Ralph C. 1 pam.
Richardson, Clifford. 1 pam.
St. Louis, Mo.-Water Commr. 1 pam.
São Paulo, Brazil-Commissão Geographica e Geologica. 1 map.
South Dakota-Board of R. R. Commrs. 2 bound vol.
Tennessee-State Geol. Survey. 1 pam.
Thomas, C. A. 1 vol.
Thompson, Slason. 1 bound vol.
Toledo, Peoria & Western Ry. Co. 1 pam.
Toronto, Ont.-City Engr. 1 bound vol.
U. S.-Bureau of Mines. 1 pam.
U. S.-Bureau of the Census. 1 bound vol.
U. S.-Chf. of Engrs. 33 specif.
U. S.-Civil Service Comm. 1 bound vol.
U. S.-Coast and Geodetic Survey. 1 map, 2 pam.
U. S.-Forest Service. 3 pam.

U. S.-National Conservation Comm. 1 pam.
U. S.-Weather Bureau. 1 bound vol.
Verein Deutscher Portland-Zement-Fabrikanten. 1 pam.
Victoria-Land and Works Board, Ry. Constr. Branch. 1 pam.
Wabash R. R. Co. 1 pam.
Western Australia-Dept. of Mines. 1 pam.
Western Ry. Club. 1 bound vol.
Wilson, W. Edward. 1 pam.
Wisconsin, Univ. of. 5 pam.
Yale Univ. 1 pam.

BY PURCHASE

The National Cyclopædia of American Biography. Supplement 1. James T. White & Company, New York, 1910.

The Mechanical Engineers' Pocket-Book, a Reference-Book of Rules, Tables, Data, and Formulæ, For the Use of Engineers, Mechanics, and Students. By William Kent. Eighth Edition, Rewritten. John Wiley & Sons, New York, 1910.

The New International Year Book, a Compendium of the World's Progress, 1908 and 1909. 2 Vol. Editor, Frank Moore Colby; Associate Editor, Allen Leon Churchill. Dodd, Mead and Company, New York, 1910.

Freight Transportation on Trolley Lines. By Charles S. Pease. McGraw-Hill Publishing Company, New York, 1909.

SUMMARY OF ACCESSIONS

(From September 13th to October 10th, 1910)

Donations (including 9 duplicates)	207
By purchase	5
Total	212

MEMBERSHIP

ADDITIONS

(September 13th to October 11th, 1910)

MEMBERS		Date of Membership.
Andros, Frederic William. Chf. Engr., Nazas Val. & Pac. Ry., Tepehaunes, Durango, Mexico	Assoc. M. M.	Feb. 1, 1899 Sept. 6, 1910
Ash, Louis Russell. City Engr., City Hall, Kansas City, Mo	Assoc. M. M.	Dec. 5, 1906 Sept. 6, 1910
Bedford, Thomas Archibald. Deputy Engr., San Diego County Highway Comm. (4640 Campus Ave.), San Diego, Cal		Sept. 6, 1910
Booth, Arthur Allen. Civ. and Min. Engr., 1026 Twelfth Ave., West, Spokane, Wash		June 30, 1910
Breed, Oliver Clark. Civ. and Hydr. Engr., Fulton, N. Y.		Sept. 6, 1910
Bryant, Byron Harkness. Chf. Engr., Mexico North Western Ry., Chihuahua, Chih., Mexico		Sept. 6, 1910
Ensign, Guert William. Asst. State Highway Commr., Harrisburg, Pa	Assoc. M. M.	Nov. 4, 1908 Sept. 6, 1910
Field, Frederick Elbert. Prin. Div. Engr., Bureau of Filtration (Res., 1130 Sherwood Pl.), Pittsburg, Pa	Assoc. M. M.	Oct. 7, 1903 Sept. 6, 1910
Filley, Oliver Dwight. Superv. Engr., Bureau of Public Works, Philippine Islands, Manila, Philippine Islands.		April 5, 1910
Gadd, Robert Foster. New England Mgr., Levering & Garrigues Co., Steel Contrs.; Address, Connecticut Mutual Bldg., Hartford, Conn		Sept. 6, 1910
Gardiner, John Peden. Civ. and Hydr. Engr., 733 Central Bldg., Los Angeles, Cal	Assoc. M. M.	Mar. 7, 1906 Sept. 6, 1910
Gibson, James Edwin. Asst. Engr., Am. Pipe and Constr. Co., 112 North Broad St., Philadelphia, Pa		Sept. 6, 1910
Hopkins, Newton Fisher. With Harrop, Hopkins & Taylor, 900 Lewis Bldg., Pittsburg, Pa	Assoc. M. M.	Oct. 2, 1907 Oct. 4, 1910
Howard, Edward Henry. 71 Billings Rd., Quincy, Mass.		May 31, 1910
Jenckes, Lawrence Bates. 46 Fruit St., Worcester, Mass	Jun. Assoc. M. M.	Mar. 31, 1891 Oct. 7, 1896 Sept. 6, 1910
Lockwood, William Frederick. Engr., M. of W., Interborough Rap. Transit Co., 165 Broadway, Room 1225, New York City		Oct. 4, 1910
McElroy, Fred Woodburn. With Bellew & Merritt Co., 226 Niagara St., Lockport, N. Y.		Sept. 6, 1910
Raymond, Alfred. Gen. Mgr., Drainage, Sewerage, and Water Board of New Orleans, 503 City Hall Annex, New Orleans, La		Sept. 6, 1910

MEMBERS (*Continued.*)

		Date of Membership.
RHETT, EDMUND MOORE. Elec. Engr., Cent. of Ga. Ry. Co., Savannah, Ga.	Jun. M.	Nov. 4, 1902 Oct. 4, 1910
SHOEMAKER, LOUIS HENRY. Engr. in Chg. of Design, Am. Bridge Co., Frick Bldg., Pittsburg, Pa.	Assoc. M. M.	Oct. 4, 1899 Sept. 6, 1910
SMETTERS, SAMUEL TUPPER. Asst. Bridge Engr., The Sanitary Dist. of Chicago, 125 Monroe St., Room 1500, Chicago, Ill.		Sept. 6, 1910
THORNTON, CHARLES JAMES. Normanhurst, Pembroke Crescent, Hove, Sussex, England		Sept. 6, 1910
YOUNG, SAMUEL MCCAIN. (Of J. F. Coleman & Co., Engrs.), 920 Hibernia Bldg., New Orleans, La.	Assoc. M. M.	June 7, 1905 Sept. 6, 1910

ASSOCIATE MEMBERS

BROWN, HARRY WILLIAM. Care, P. C. C. & St. L. Ry., Logansport, Ind.		April 5, 1910
BRUCE, JOHN AUGUSTUS. 640 Bee Bldg., Omaha, Nebr.		Sept. 6, 1910
BURKE, RALPH HANEY. Computer, Sanitary Dist. of Chicago, 1546 South Kedzie Ave., Chicago, Ill.	Jun. Assoc. M.	Dec. 4, 1906 Oct. 4, 1910
CARR, DEAN ORRICE. Asst. to Designing Engr., Central Water-Works, Box 141, Birmingham, Ala.		Oct. 4, 1910
CLARK, ARTHUR EDWARD. Asst. Engr., New York State Public Service Comm., First Dist., 23 Flatbush Ave., Room 405, Brooklyn, N. Y.		Oct. 4, 1910
COE, ROBERT. 1317 Spruce St., Philadelphia, Pa.		Sept. 6, 1910
COLLINS, FRANCIS WINFIELD. 346 Broadway, New York City	Jun. Assoc. M.	Jan. 2, 1906 Sept. 6, 1910
COLTMAN, ROBERT, 3D. P. O. Box 166, Lachine Locks, Que., Canada		Oct. 4, 1910
COX, CHARLES BARROWS. Asst. Engr., U. S. Reclamation Service, Mabton, Wash.		Sept. 6, 1910
CRAWLEY, ERNEST WILLARD. U. S. Junior Engr., 407 First National Bank Bldg. (Res., 299 Norton St.), New Haven, Conn.	Jun. Assoc. M.	May 31, 1904 Sept. 6, 1910
DAMBACH, WILLIAM NICHOLAS. Junior Engr., U. S. Engr. Office, Wheeling, W. Va.		Sept. 6, 1910
EBERLY, CLARENCE FREDERICK. Asst, Topographer, U. S. Geological Survey, Beverly, Wash.		Sept. 6, 1910
HAGUE, WILLIAM. 22 William St., New York City		Oct. 4, 1910
HARTUNG, PAUL AUGUST. Civ. and Irrig Engr., Greeley, Colo.		Sept. 6, 1910
HASELWOOD, FRED WILLIS. 675 Monadnock Bldg., San Francisco, Cal.	Jun. Assoc. M.	Jan. 3, 1907 Sept. 6, 1910

ASSOCIATE MEMBERS (*Continued.*)

		Date of Membership.
Hayes, Andrew Jenkins. Care, U. S. Reclamation Service, Fort Shaw, Mont		Sept. 6, 1910
Hendricks, Kearney Everett. Instr. in Civ. Eng., Lehigh Univ., South Bethlehem, Pa		Oct. 4, 1910
Hidinger, Leroy Lemayne. 612 Goodwyn Inst. Bldg., Memphis, Tenn		Oct. 4, 1910
James, Merton Earle. Barge Canal Office, Amsterdam, N. Y		Oct. 4, 1910
Jewett, John Young. Cement Expert, U. S. Reclamation Service, 408 Commonwealth Bldg., Denver, Colo		Sept. 6, 1910
Leeuw, Henry Alexander. Care, Glyndon Contr. Co., Yorktown Heights, N. Y	Jun. Assoc. M.	Sept. 5, 1905 Oct. 5, 1909
McClintock, James Robinson. Res. Engr., Hering & Fuller, 314 Oak Hall Bldg., Clarksburg, W. Va	Jun. Assoc. M.	Oct. 2, 1906 May 3, 1910
Martin, John. Civ. Engr. and City Surv., 2078 Wiegand Pl., Bronx, New York City		May 31, 1910
Meem, James Lawrence. Mt. Jackson, Va		Oct. 4, 1910
Mosley, Earl Louis. Chf. Engr., Grand Junction & Grand River Val. Ry. Co., Grand Junction, Colo		Sept. 6, 1910
Murray, John Bonaventure. Care, Lehigh Car Wheel & Axle Works, 50 Church St., New York City		Sept. 6, 1910
O'Connell, George Paul. Asst. Engr., Board of Water Supply of New York City, Brown Station, N. Y		Sept. 6, 1910
Peden, Leo Thomas. (Peden-Eller Co.), 3009 Bagby St., Houston, Tex		May 31, 1910
Rapalje, Herbert deWitt. Cons. Engr., Room 511, Southern Bldg., Wilmington, N. C		Sept. 6, 1910
Rhett, Albert Haskell. Structural Engr., N. Y., Westchester & Boston Ry. Co., 65 Beaver St., New York City		Sept. 6, 1910
Robinson, Ernest Franklin. U. S. Engr. Office, Room 710, Army Bldg., New York City	Jun. Assoc. M.	Mar. 3, 1908 Oct. 4, 1910
Smith, Donald David. (Donald D. Smith Co.), 810 Surety Bldg., Muskogee, Okla		Sept. 6, 1910
Snell, Roy Martin. Asst. Engr., U. S. Reclamation Service, Family, Mont		Sept. 6, 1910
Sullivan, Murray. Chf. Draftsman, Eng. Dept., Oregon Short Line R. R. Co., 606 Deseret News Bldg., Salt Lake City, Utah		Sept. 6, 1910
Tallman, Paul Bertram. No. 8 Warrington Apartments, Cor., Bell and Fannin Sts., Houston, Tex	Jun. Assoc. M.	Oct. 3, 1905 Sept. 6, 1910
Tarver, Thomas Cary, Jr. City Engr., 1504 Capitol St., Houston, Tex		Sept. 6, 1910

ASSOCIATE MEMBERS (*Continued*).

		Date of Membership.
Trott, David Crooker. Supt. of Constr. with Superv. Archt., U. S. Treasury Dept.; Address, Appleton, Wis.		Sept. 6, 1910
Walker, Albert Willard. Asst. Engr., U. S. Reclamation Service, Orman, S. Dak.		May 3, 1910
Warner, John Elliott. County Surv. and Highway Engr., Scott County, Benton, Scott Co., Mo.		Sept. 6, 1910
Waterbury, Leslie Abram. Prof. of Civ. Eng., Univ. of Arizona, Tucson, Ariz.	Assoc. Assoc. M.	Nov. 7, 1906 June 30, 1910
Welborn, Marvin Curtis. Engr., Water, Light and Power Dept., City of Austin, Austin, Tex.		Nov. 8, 1909
Whipple, Robert Lee. With U. S. Govt. Naval Magazine, Hingham, Mass.		Sept. 6, 1910
Whitaker, William Franklin. Supt. of Canals, Kern County Canal & Water Co., 2620 Nineteenth St., Bakersfield, Cal.	Jun. Assoc. M.	April 4, 1905 Sept. 6, 1910
Whitsit, Lyle Antrim. Prin. Asst. Engr., Long Sault Development Co. and St. Lawrence River Power Co., Massena, N. Y.	Jun. Assoc. M.	Oct. 31, 1905 Sept. 6, 1910

JUNIORS

	Date of Membership.
Bailey, Clifton George. Sub.-Insp., U. S. Naval Station, Key West, Fla.	Sept. 6, 1910
Bortin, Harry. Asst. Engr., U. P. R. R., 11th and Farnum Sts., Omaha, Nebr.	Sept. 6, 1910
Cary, Richard Lucius. 23 Madison St., Princeton, N. J.	June 30, 1910
Coleman, Lester Lyman. Asst Engr. with City Engr., 253 Carl St., San Francisco, Cal.	May 31, 1910
Currey, John Waggoner. Deputy County Surv., Wagoner Co., Wagoner, Okla.	Sept. 6, 1910
Eide, Torris. Asst. Engr., Designing Div., Board of Water Supply, 165 Broadway, New York City	Sept. 6, 1910
Gaynor, Keyes Christopher. Sioux City, Iowa	June 30, 1910
Gillespie, Chester Gordon. 1536 Walnut St., Berkeley, Cal.	Sept. 6, 1910
Graham, Guy Alexander. Engr. with Snare & Triest Co., Cold Spring, N. Y.	Sept. 6, 1910
Grannis, James Kidwell. Engr., H. L. Stevens & Co., Ft. Worth, Tex.	Sept. 6, 1910
Kinney, William Morton. Asst. Inspecting Engr., Universal Portland Cement Co., 530 Frick Bldg., Pittsburg, Pa.	Sept. 6, 1910
Mack, George Horace. Dows, Wright Co., Iowa	Sept. 6, 1910

JUNIORS (*Continued*).

	Date of Membership.
Marsh, Charles Reed. Civ. Engr. and Superv. of Constr., Quartermaster's Dept., U. S. A., Boston (Res., 52 Ivy St., Brookline), Mass	June 30, 1910
Overocker, Daniel Willets. Barge Canal Office, Amsterdam, N. Y	Oct. 4, 1910
Parlin, Raymond Washington. 3 Forest Park, North Cambridge, Mass	June 30, 1910
St. John, Walter Sherman. 341 Edgecomb Ave., New York City	Sept. 6, 1910
Smoyer, Lloyd Isadore. With Post & McCord, 44 East 23d St., New York City	Oct. 4, 1910

CHANGES OF ADDRESS

MEMBERS

Anderson, George Gray. Cons. Engr., Room 1232 First National Bank Bldg., Denver, Colo.

Argollo, Miguel de Teive e. Caixa Postal 226, Bahia, Brazil.

Binckley, George Sydney. Cons. Engr., 1108 Union Trust Bldg., Los Angeles, Cal.

Buehler, Walter. Vice-Pres., Kettle River Quarries Co., 3041 Park Ave., Minneapolis, Minn.

Burt, Henry Jackson. Contr. Mgr., Am. Bridge Co. of New York, 1218 National Bank Bldg., Denver, Colo.

Chapman, James Russell. 1712 Anacapa St., Santa Barbara, Cal.

Child, Stephen. 6 Beacon St., Room 217, Boston, Mass.

Dabney, Augustine Lee. Asst. Chf. Engr., Tallahatchie Drainage Comm., Tunica, Miss.

Dennis, William Franklin. Cons. Engr.; Pres., Rinehart & Dennis Co., Gen. Ry. Contrs., 1407 Sixteenth St., Washington, D. C.

Elliott, James William. 17 Adsit Pl., Burlington, Vt.

Farley, John Moyer. Cons. Engr., 527 Fifth Ave., New York City.

Farnham, Robert, Jr. Asst. Engr. of Constr., P. R. R., Broad St. Station, Philadelphia, Pa.

French, Owen Bert. Asst., Coast and Geodetic Survey, Washington, D. C.

Handbury, Thomas Henry. Col., Corps of Engrs., U. S. A. (*Retired*), Care, Hong Kong-Shanghai Banking Corporation, Tientsin, China.

Haring, James Smith. 35 Bradford Ave., Crafton, Pa.

Harrison, Charles Lewis. 7 East 42d St., New York City.

Henny, David Christiaan. Cons. and Hydr. Engr., 605 Spalding Bldg., Portland, Ore.

Hewett, Bertram Henry Majendie. Care, Jacobs & Davies, 30 Church St., New York City.

Hittell, John Benjamin. Chf. Engr. of Streets, Board of Local Impvts., 300 City Hall (Res., 5917 Winthrop Ave.), Chicago, Ill.

Hobby, Arthur Stanley. Cons. Engr., 88 Madison Ave., New York City.

Howard, Charles Pope. Chesuncook, Me.

MEMBERS (*Continued.*)

HURRY, EDWARD HENRY. Llanover, Churt, Farnham, England.

INGALLS, OWEN LOVEJOY. 2148 P St., N. W., Washington, D. C.

KAREISCHA, SERGE DE. Prof. of the Imperial Inst. of Engrs. of Ways and Communications; Asst. Gen. Mgr., Traffic Dept., Board of Direction, Russian Rys.; Pres., Assoc. of M. of W. Engrs., Russian Ry., Kasatchy pereoulok No. 6, log 6, St. Petersburg, Russia.

KIEFFER, STEPHEN EPHRAIM. Civ. and Hydr. Engr., Room 630 First National Bank Bldg., Oakland, Cal.

KNOX, SAMUEL LIPPINCOTT GRISWOLD. Care, M. Burr, Jr. & Co., 20 Broad St., New York City.

LYNCH, MICHAEL LEHANE. 425 Hamilton Ave., Jackson, Mich.

MACCALLA, CLIFFORD SHERRON. Asst. Gen. Mgr., The Washington Water Power Co., Box 215, Spokane, Wash.

McCOY, SAMUEL ALEXANDER. Contr. (Boynton, Church & McCoy), 1725 Eleventh Ave., Spokane, Wash.

MARR, WILLIAM WALTER. 1240 Cornelia Ave., Chicago, Ill.

MILES, JOHN WILEY. Care, G. P. De Wolf, Estacion Golfo, Monterey, Mexico.

MILLER, HIRAM ALLEN. Cons. Engr., Metropolitan Park Comm., 14 Beacon St., Room 507, Boston (Res., 15 Duncklee St., Newton Highlands), Mass.

MOORE, WILLIAM EDWIN. Cons. Engr., 220 Paulson Bldg., Spokane, Wash.

OSTRUP, JOHN CHRISTIAN. Prof. of Structural Eng., Stevens Inst. of Tech., Hoboken, N. J.; Cons. Engr., 202 West 103d St., New York City.

PERKINS, CHARLES EZRA. Akron, Ohio.

PERKINS, EDMUND TAYLOR. (Edmund T. Perkins Eng. Co.), First National Bank Bldg., Chicago, Ill.

REED, MELVILLE EMERSON. Prin. Asst. Engr., Orgeon Elec. Ry.; Address, 751 Wiedler St., Portland, Ore.

RICH, EDWARD DUNBAR. Asst. Prof. of Civ. Eng., Univ. of Michigan, 901 Forrest Ave., Ann Arbor, Mich.

SANDO, WILL JOSEPH. Care, Milwaukee Club, Milwaukee, Wis.

SEAMAN, HENRY BOWMAN. 140 Clinton St., Brooklyn, N. Y.

SEARS, ALFRED FRANCIS. 52 East 6th St., North, Portland, Ore.

SMITH, MERRITT HAVILAND. Deputy Chf. Engr., Board of Water Supply, City of New York, 165 Broadway, Room 721, New York City (Res., Kensico, N. Y.).

SPOONER, ALLEN NEWHALL. 11 West 88th St., New York City.

STERN, ISAAC FARBER. Engr. of Bridges, C. & N. W. R. R., 5326 Michigan Ave., Chicago, Ill.

STURTEVANT, CARLETON WILLIAM. Supt., James Stewart & Co., Baldwinsville, N. Y.

SUTER, CHARLES RUSSELL. Brig.-Gen., U. S. A. (*Retired*), 287 Walnut St., Brookline, Mass.

TOWLE, STEVENSON. Civ. and Cons. Engr., 17 West 90th St., New York City.

VAN CLEVE, AARON HOWELL. City Engr., London, Ont., Canada.

MEMBERS (*Continued.*)

VORCE, CLARENCE BROWNING. Chf. Engr., British Columbia Elec. Ry. Co., Ltd., Vancouver, B. C., Canada.

WALKER, MERIWETHER LEWIS. Maj., Corps of Engrs., U. S. A., Ft. Leavenworth, Kans.

WENZELL, ANDREW JACKSON. Cons. Engr., 107 W. Hancock, Detroit, Mich.

ZINN, GEORGE ARTHUR. Lt.-Col., Corps of Engrs., U. S. A., 508 Federal Bldg., Chicago, Ill.

ASSOCIATE MEMBERS

BASCOME, WESTERN RADFORD. Asst. to Chf. Engr., Dept. of Bridges, 13 Park Row (Res., 140 Claremont Ave.), New York City.

BERRY, FRANCIS RIGDON. Care, The Water Co., St. Joseph, Mo.

BLAND, MILES CARLISLE. Chf. Engr., Massillon Bridge & Structural Co., Massillon, Ohio.

BLIEM, DANIEL WILLIAM. Asst. to Operating Mgr., Am. Bridge Co., Pennsylvania Bldg., Philadelphia, Pa.

BROOKS, MILES ELIJAH. Locating Engr., Kettle Val. Lines, Midway, B. C., Canada.

CAMERON, HARRY FRANK. Div. Engr., Bureau of Public Works, Manila, Philippine Islands.

CHAPMAN, HARRY DAY. City Engr. and Supt. of Streets, Richmond, Cal.

CHARLES, LAVERN JOHN. Care, U. S. Reclamation Service, Easton, Wash.

CONZELMAN, JOHN EDWARD. Chf. Engr., Unit Constr. Co., 1101 Liggett Bldg., St. Louis, Mo.

CULGIN, GUY WHITMORE. Asst. Engr., Rapid Transit Subway Constr. Co., 165 Broadway (Res., 410 West 148th St.), New York City.

CUNNINGHAM, JOHN GEORGE LAWRENCE. Bldg. Insp., 497 Dayton Ave., St. Paul, Minn.

CUTTING, GEORGE WARREN, JR. Civ. Engr., U. S. A., Care, Chf. Quartermaster, Philippine Div., U. S. A., Manila, Philippine Islands.

DAVENPORT, JAMES WATSON. Care, Tatum Lumber Co., Hattiesburg, Miss.

DIAMANT, ARTHUR HERBERT. Engr., Blaw Collapsible Steel Centering Co., Westinghouse Bldg., Pittsburg, Pa.

DORSEY, LEANDER. Supt., The Whiting-Middleton Constr. Co., Sexton Bldg., Baltimore, Md.

ELLIOTT, MALCOLM. Care, U. S. Engr. Office, Room 425, Custom House, Louisville, Ky.

FURLOW, FELDER. 1240 Maplewood St., Birmingham, Ala.

GRANT, KENNETH CROTHERS. 1804 Arrott Bldg., Pittsburg, Pa.

GRAVES, WILLARD FRANKLIN. 4563 Woodlawn Ave., 3d Apartment, Chicago, Ill.

HARBECK, HENRY RUSSELL. Engr. and Supt. of Constr., Leonard Constr. Co., 1937 McCormick Bldg., Chicago, Ill.

HEINDLE, WILLIAM ALBERT. Mgr. of Rys., Wilmington & Philadelphia Traction Co. and Southern Pennsylvania Traction Co., 603 Market St., Wilmington, Del.

ASSOCIATE MEMBERS (*Continued*).

HUNICKE, WILLIAM AUGUST. Engr. of Constr., Cuban Central Ry., Sagua La Grande, Cuba.

HURLBUT, HINMAN BARRETT. Engr. Expert Aid, Bureau of Yards and Docks, Navy Dept. (1822 U St., N. W.), Washington, D. C.

JOHNSON, EDWIN SAMUEL. 412 Keystone Bank Bldg., Pittsburg, Pa.

KAFKA, FREDERICK PERCEVAL. Pres., Herringbone Metal Lath Co., 257 East 133d St., New York City (Res., 49 Washington Ave., New Rochelle, N. Y.).

KING, EVERETT EDGAR. 717 East Buffalo St., Ithaca, N. Y.

KLOSSOWSKI, THEODORE JULIUS. 1211 Fifth Ave., Spokane, Wash.

LEE, GEORGE WILLIAM. Chf. Engr., Sundstrom & Stratton, New York City; Address, 26 Elm St., New Rochelle, N. Y.

LEE, JOHN LOUIS. Care, MacArthur Concrete Pile & Foundation Co., Seattle, Wash.

McGREGOR, ROBERT ROY. Care, J. R. McGregor, Lompoc, Cal.

McNEIL, ARTHUR JAMES. Care, Lewis Parker, Tracy, Cal.

MANCHESTER, ERNEST JAMES THEODORE. Pres., Water Supply and Sewerage Board, Brisbane, Australia.

MOULD, GEORGE ALEXANDER HUTCHINGS. 255 West 111th St., New York City.

MURRAY, CHARLES WARREN. Florence, S. C.

PATTERSON, CLAIR BRANDON. 2832 Fifth Ave., Beaver Falls, Pa.

PEOTTER, REUBEN SYLVESTER. 85 Livingston St., Brooklyn, N. Y.

PRATT, ARTHUR HENRY. 24 Summit Ave., White Plains, N. Y.

RANKIN, HARRY HOWARD. Civ. and Min. Engr., 1321 Park Bldg. (Res., 819 St. James St.), Pittsburg, Pa.

REID, HOMER AUSTIN. Asst. Engr., Bureau of Bldgs., Borough of Manhattan (Res., 628 West 147th St.), New York City.

SAVAGE, SEWARD MERRILL. Res. Engr., Barge Canal, 196 Genesee St., Utica, N. Y.

SEABURY, GEORGE TILLEY. Asst. Engr., Board of Water Supply of New York City, Valhalla, N. Y.

SMITH, GEORGE EDSON PHILIP. Univ. of Wisconsin, Madison, Wis.

STEPHENSON, STUART AUGUSTUS, JR. Instr. in Math. and Graphics, Rutgers Coll. (Res., 266 Redmond St.), New Brunswick, N. J.

STEVENS, JOHN CYPRIAN. Civ. and Hydr. Engr., 605 Spalding Bldg., Portland, Ore.

SULLIVAN, JOHN FRANCIS. Asst. Engr., Office of Cons. Engr., Borough of Manhattan (Res., 610 West 139th St.), New York City.

TEIGEN, THOMAS WILLIAM ROSTAD. Office Engr., Mexico North Western Ry., Nueva Cascas Grandes, Chih., Mexico.

THURBER, CLINTON DRAPER. Asst. Civ. Engr., U. S. N., Naval Station, North Chicago, Ill.

VERVEER, EMANUEL LOUIS. Structural Engr., 201 West 105th St., Apartment 2C, New York City.

WENTWORTH, CHARLES AUSTIN. Cons. Engr., 216 Bloomingdale Ave., Wayne, Pa.

ASSOCIATE MEMBERS (*Continued*).

WHITE, WILLARD OLNEY. First National Bank Bldg., Uniontown, Pa.

WILCOX, FRANK LESLIE. Hydr. and San. Engr., 612 Victoria Bldg., St. Louis, Mo.

WILSON, WILBUR THOMAS. 520 West 122d St., New York City.

WOOD, ROBERT WALTER. Asst. Engr. in Chg. of Port Richmond Div., Borough of Richmond, New York City, 913 Post Ave., Port Richmond, N. Y.

YOUNG, HENRY AMERMAN. 19 Beaver St., New York City (Res., 18 Belmont Ave., Yonkers, N. Y.).

ASSOCIATES

ATWELL, HARRY HURD. Instr. in Surv., Univ. of Michigan, 2305 Geddes Ave., Ann Arbor, Mich.

McBURNEY, HENRY. Care, A. W. Buel, 15 William St. (Res., 38 East 31st St.), New York City.

JUNIORS

ABRONS, LOUIS WILLIAM. 75 West 101st St., New York City.

BORLAND, BRUCE. 1508 Borland Blk., Chicago, Ill.

BROWN, DAVID HARELL. Engr., M. of W., Salt Lake & Ogden Ry., 461 Main St., Salt Lake City, Utah.

BRUA, ELMER GEORGE. Care, Associated Oil Co., Wells Fargo Bldg., San Francisco, Cal.

CORP, HENRY WILLIAM. Care, Manila R. R. Co., Manila, Philippine Islands.

DENSLER, FRANK HASKELL. Asst. Engr., Board of Water Supply of New York City; Address, 805 Prospect Pl., Brooklyn, N. Y.

DOOLITTLE, FREDERICK WILLIAM. 204 North Brooks St., Madison, Wis.

EDGERTON, GLEN EDGAR. 2d Lieut., Corps of Engrs., U. S. A., Washington Barracks, D. C.

ELLIS, HERBERT CRAM. Y. M. C. A. Bldg., White Plains, N. Y.

FINCH, JAMES KIP. Dept. of Civ. Eng., Columbia Univ. (Res., 306 West 93d St.), New York City.

FISHER, WILBUR HOWARD. 908 Spofford Ave., Spokane, Wash.

FORSYTH, HAROLD FREDERICK. Box 223, University Station, Seattle, Wash.

FOSS, JAMES CALVIN, JR. Res. Engr., Pahu Sugar Co., Ltd., Waipahu (Res., 1835 Makiki St., Honolulu), Hawaii.

GARDNER, HARRY CARTER. Instr., Civ. Eng., Univ. of Pennsylvania, 3718 Walnut St., Philadelphia, Pa.

GAY, ROBERT WALTER. Agricultural Coll., Oktibbeha Co., Miss.

GREEN, CLARENCE JASPER. 517 East Catherine St., Ann Arbor, Mich.

HAMILTON, EDWARD PARMELEE. With Snare & Triest, 143 Liberty St., New York City (Res., 131 Depew St., Peekskill, N. Y.).

HESS, JOHN STRIDER. 1603 East North Ave., Baltimore, Md.

HORNER, WESLEY WINANS. 5203 Maple Ave., St. Louis, Mo.

HOWE, CLARENCE DECATUR. Dalhousie Univ., Halifax, Nova Scotia.

JONES, IRVING PAUL. Asst. Engr., Mexican Ry., Fortin, Vera Cruz, Mexico.

LEWIS, WILFRED. Care, MacArthur Concrete Pile & Foundation Co., 514 Terry Ave., Seattle, Wash.

JUNIORS (*Continued*).

McCAMPBELL, ALFRED KESSINGER. U. S. Post Office, Shanghai, China.

McCLURE, HARRY CLIFFORD. Y. M. C. A., Toledo, Ohio.

McCLURE, HUNTER. Hill Crest, Ithaca, N. Y.

MERRITT, CHARLES EDWARD. 351 Genesee St., Utica, N. Y.

MILLER, HUGH. Prof. of Civ Eng., Clarkson School of Technology, 1 Chestnut St., Potsdam, N. Y.

MUCHEMORE, HARRIE LANGDON. Expert Aid, Office of Insp., Public Works, Navy Yard, New York City; Address, 265 Orchard St., Elizabeth, N. J.

MUNKELT, FREDERICK HERMANN. 668 East 13th St., Brooklyn, N. Y.

NEUHARDT, EDWIN. Box 321, Savannah, Ga.

OSBORN, KENNETH HOWARD. Care, Osborn Eng. Co., Osborn Bldg., Cleveland, Ohio.

PETERS, JOHN MARVIN. Asst. Engr., Mo. Pac.-Iron Mountain System (Res., 5143 Maple Ave.), St. Louis, Mo.

RASCHBACHER, HARRY GEORGE. 110 La Salle St., Suite 525, Chicago, Ill.

RIEGEL, ROSS MILTON. Care, Board of Water Supply, 165 Broadway, New York City.

SACKETT, ARTHUR JOHNSON. Instrumentman, Penn. T. & T. R. R. Co., 345 East 33d St., New York City.

SHAW, WALTER FARNSBY. Care, Dept. of Highways, 120 W. Jefferson St., Syracuse, N. Y.

SUAREZ Y CORDOVES, PATRICIO ANDRES. Central "Esperanza," Calimete, Cuba.

TOLLES, FRANK CLIFTON. Chf. of Party, Commrs. of Sewerage, The Chesterfield Apartments, Louisville, Ky.

TYLER, RICHARD GAINES. Instr. in Civ. Eng., Texas Univ., 1510 West Ave., Austin, Tex.

VANDERVOORT, BENJAMIN FRANKLIN. Asst. Engr., State Water Supply Comm., Albany, N. Y.

WALKER, CHARLES LEOPOLD. Asst. Prof. in Civ. Eng., Cornell Univ., 218 University Ave., Ithaca, N. Y.

WARD, EDWARD ASHTON. Eng. Dept., N. Y. C. R. R., Grand Central Station, New York City (Res., 1197 Broad St., Newark, N. J.).

WILBANKS, JOHN ROBERT. 518 Vermont Bldg., Salt Lake City, Utah.

WILLCOX, JAMES DEWITT. 1201 East 16th Ave., Denver, Colo.

WILLIS, ALBERT JONES. Instr. in Civ. Eng., Cooper Union (Res., 499 East 176th St.), New York City.

RESIGNATION

ASSOCIATE MEMBER	Date of Resignation.
HITCHMAN, JACKSON COLBORN..............................	Oct. 4, 1910.

DEATH

ARCHBALD, JAMES. Elected Member, May 15th, 1872; died October 5th, 1910.

Total Membership of the Society, October 11th, 1910, 5 688.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(September 13th to October 10th, 1910)

NOTE.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal,* Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings,* Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions,* Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly,* Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator,* Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine,* New York City, 25c.
(10) *Cassier's Magazine,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News,* New York City, 15c.
(14) *Engineering Record,* New York City, 12c.
(15) *Railway Age Gazette,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway and Engineering Review,* Chicago, Ill., 10c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 10c.
(21) *Railway Engineer,* London, England, 25c.
(22) *Iron and Coal Trades Review,* London, England, 25c.
(23) *Bulletin,* American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal,* New York City, 10c.
(25) *American Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique,* Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France.
(34) *Portefeuille Economiques des Machines,* Paris, France.
(35) *Nouvelles Annales de la Construction,* Paris, France.
(37) *Revue de Mécanique,* Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways,* Paris, France.
(41) *Modern Machinery,* Chicago, Ill., 10c.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(44) *Journal,* Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals,* Scranton, Pa., 20c.
(46) *Scientific American,* New York City, 8c.
(47) *Mechanical Engineer,* Manchester, England.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(51) *Deutsche Bauzeitung,* Berlin, Germany.
(52) *Rigasche Industrie-Zeitung,* Riga, Russia.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions,* Am. Soc. C. E., New York City, $4.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $5.

(57) *Colliery Guardian*, London, England.
(58) *Proceedings*, Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.
(59) *Transactions*, Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.
(60) *Municipal Engineering*, Indianapolis, Ind., 25c.
(61) *Proceedings*, Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *Industrial World*, 59 Ninth St., Pittsburg, Pa.
(63) *Minutes of Proceedings*, Inst. C. E., London, England.
(64) *Power*, New York City, 20c.
(65) *Official Proceedings*, New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Journal of Gas Lighting*, London, England, 15c.
(67) *Cement and Engineering News*. Chicago, Ill., 25c.
(68) *Mining Journal*, London, England.
(70) *Engineering Review*, New York City, 10c.
(71) *Journal*, Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs*, Iron and Steel Inst., London, England.
(73) *Electrician*, London, England, 18c.
(74) *Transactions*, Inst. of Min. and Metal., London, England.
(75) *Proceedings*, Inst. of Mech. Engrs., London, England.
(76) *Brick*, Chicago, Ill., 10c.
(77) *Journal*, Inst. Elec. Engrs., London, England.
(78) *Beton und Eisen*, Vienna, Austria.
(79) *Forscherarbeiten*, Vienna, Austria.
(80) *Tonindustrie Zeitung*, Berlin, Germany.
(81) *Zeitschrift für Architektur und Ingenieurwesen*, Wiesbaden, Germany.
(83) *Progressive Age*, New York City, 15c.
(84) *Le Ciment*, Paris, France.
(85) *Proceedings*, Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.
(86) *Engineering-Contracting*, Chicago, Ill., 10c.
(87) *Roadmaster and Foreman*, Chicago, Ill., 10c.
(88) *Bulletin* of the International Ry. Congress Assoc., Brussels, Belgium.
(89) *Proceedings*, Am. Soc. for Testing Materials, Philadelphia, Pa.
(90) *Transactions*, Inst. of Naval Archts., London, England.
(91) *Transactions*, Soc. Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin*, Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie*, Paris, France, 4 fr. 50.
(94) *The Boiler Maker*, New York City, 10c.
(95) *International Marine Engineering*, New York City, 20c.
(96) *Canadian Engineer*, Toronto, Ont., Canada, 15c.
(97) *Turbine*, Berlin, Germany, 1 Mark.
(98) *Journal*, Engrs. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.
(99) *Proceedings*, Am. Soc. of Municipal Improvements, New York City, $1.50.
(100) *Professional Memoirs*, Corps of Engrs., U. S. A., Washington, D. C., $1.
(101) *Metal Worker*, New York City, 10c.
(102) *Organ für die Fortschritte des Eisenbahnwesens*, Wiesbaden, Germany.
(103) *Mining and Scientific Press*, San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer*, London, England, 6d.
(105) *Metallurgical and Chemical Engineering*, New York City, 25c.

LIST OF ARTICLES.

Bridges.

An Armoured Concrete Viaduct at Rotterdam.* (12) Sept. 9.
The Construction Methods on the Rocky River Bridge, with Some Costs.* (86) Sept. 14.
Removal of Wrecked Superstructure, Quebec Bridge.* (14) Sept. 17.
The Erection of the Broad River Bridge.* (14) Sept. 17.
Standard I-Beam Railroad Bridges over City Streets.* (14) Sept. 17.
The Plant for Constructing the Quebec Bridge Substructure.* (14) Sept. 24.
The North Caisson of the Quebec Bridge.* (14) Oct. 1.
The Quebec Bridge (Specifications). (From *Iron Trade Review.*) (18) Oct. 1.
Effect of Engine Gases on Unprotected Steel Viaducts.* Arthur Sullivan. (86) Oct. 5.
The New Quebec Bridge.* (96) Oct. 6.
Erection and Elevation of a Double-Track Drawbridge under Traffic.* W. L. Six, M. W. S. E. (13) Oct. 6.
Sur le Tracé Pratique de Certaines Courbes Transcendantes Utilisables dans la Construction des Ponts.* Maurice D'Ocagne. (43) July.
Viaduc de Saint-Jean-la-Rivière; Chemin de Fer Electrique de la Vallée de la Vésubie (Alpes-Maritimes.)* James Boudet. (35) Sept.

---

* Illustrated.

Electrical.

An Account of a Visit to the Power Plant of the Ontario Power Co. at Niagara Falls.* C. W. Jordan. (75) Jan.
Transmission Line Calculations.* Alfred Still. (27) Sept. 15.
Commercial Wireless Telegraphy in Japan; the Teishinsho System.* Wichi Torikata. (73) Sept. 16.
A Dispute of Electric Power Service. (14) Sept. 17.
Comparative Life Test of Incandescent Lamps.* Clayton H. Sharp and Preston S. Millar. (27) Sept. 22.
The Electrostatic Capacity between Equal, Parallel Wires.* H. Pender and H. S. Osborne. (27) Sept. 22.
Steel Transmission Towers.* J. Edw. Jennings. (Paper read before the Brooklyn Engrs.' Club.) (96) Sept. 22.
The Electrical Installation at Bikaner, India.* (26) Sept. 23.
Voltage Drop of Transformers having a Poor Regulation.* K. Faye-Hansen. (73) Sept. 23.
The Design and Efficiency of High-Tension Insulators.* A. O. Austin. (Abstract of paper read before the Central Elec. Ry. Assoc.) (17) Sept. 24.
The Development of the Wave-Meter in Wireless Telegraphy.* George Seibt. (27) Sept. 29.
Hydro-Electric Developments and High Tension Practice.* Percy H. Thomas. (100) Oct.
Potential Stresses in Dielectrics.* Harold S. Osborne and Harold Pender. (42) Oct.
The Comparison of Galvanometers and a New Type of Flat-Coil Galvanometer.* Edwin F. Northrup. (3) Oct.
Electric Power and Lighting in Railway Shops.* (Abstract of report to the Assoc. of Ry. Elec. Engrs.) (13) Oct. 6; (18) Oct. 8.
Motor Load of Massachusetts Central Stations. Walter Stuart Kelley. (27) Oct. 6.
The Reconstruction of the New York Fire Alarm Telegraph System. (46) Oct. 8.

Marine.

The Melville & Macalpine Reduction Gear.* J. A. MacMurchie. (98) Sept.
Marine Boiler Construction.* John Creen. (94) Sept.
The Brown-Curtis Turbine Installation in H. M. S. *Bristol*.* (11) Sept. 30.
New American-Hawaiian Steamers.* (95) Oct.
Column Tables for Ship Work.* R. Earle Anderson. (95) Serial beginning Oct.
Application of Electricity to Marine Work.* (27) Oct. 6.
Démolition en Ventouse d'un Pavement du Bajoyer du Pertuis de Communication entre les Bassins du Port de Saint-Nazaire.* Le Trocquer. (43) July.
Matériel de la Batellerie et Essais de Résistance à la Traction.* Ch. Lavaud. (32) July.
Le Submersible Norvégien *Kobben* et les Submersibles du Type *Germania*.* (33) Sept. 24.

Mechanical.

Economy and Design of Modern Reversing Rolling-Mill Steam Engines.* Eduard G. Sehmer and R. Drawe. (71) Vol. 81.
Development in the Production of Electric Power; its Application and Bearing upon the Iron and Steel Industries. D. Selby Bigge. (71) Vol. 81.
Economy of an Electric Drive in a Machine Shop. (41) Serial beginning Sept.
Vibration in House Services. (28) Sept.
The Production of Power by Steam Turbines.* J. R. Bibbins. (98) Sept.
Gaseous Combustion.* William A. Bone. (Paper read before the Brit. Assoc.) (66) Sept. 6.
Gaseous Explosions (Report of Comm. to the Brit. Assoc.) (11) Serial beginning Sept. 9; (47) Serial beginning Sept. 9; (66) Sept. 6.
The Naval, Mercantile Marine and General Engineering and Machinery Exhibition, Olympia.* (11) Serial beginning Sept. 9; (12) Serial beginning Sept. 9.
The Value of Anchored Tests of Aerial Propellors.* Walter A. Scoble and S. C. Carter. (Paper read before the Brit. Assoc.) (11) Sept. 9.
The Work of the Government Aeronautical Committee.* (12) Serial beginning Sept. 9.
The Velocity of the Circulating Water in Surface Condensers.* R. M. Neilson. (12) Sept. 9.
Canada's Experimental Peat Plants.* A. R. Maujer. (64) Sept. 13.
Recent Developments in Rotary Engines.* (13) Sept. 15.
Steam Turbines for Both High and Low Pressure.* (20) Sept. 15.
Seamless Steel Tube Manufacture.* J. F. Springer. (20) Sept. 15.
Central Station at Attleboro, Mass.* (27) Sept. 15.
Light Alloys for Aeronautical Purposes. W. Rosenhain. (47) Sept. 16.

---

* Illustrated.

Mechanical—(Continued).

The Commercial Solution of the Problem of Utilising, for the Production of Power, the Energy of Solar Radiation, the Wind and other Intermittent Natural Resources. R. A. Fessenden. (Paper read before the Brit. Assoc.) (73) Sept. 16.
Progress in the Use of Exhaust-Steam Power.* J. Burns. (Paper read before the Inst. of Min. Engrs.) (22) Sept. 16.
The Elliott-Jones Vertical Coke-Oven.* T. Campbell-Futers. (Paper read before the Inst. of Min. Engrs.) (22) Sept. 16.
Blast-Furnace Charging with Telpher Lines.* (22) Sept. 16.
The Cement Mill of the Los Angeles Aqueduct.* (14) Sept. 17.
The Power Plant of the Bigelow Carpet Company.* (14) Sept. 17.
Metropolitan Home Office Plant.* F. L. Johnson. (64) Sept. 20.
A New Grab Bucket for Ore and Coal-Handling Plants and Contractors' Use.* (13) Sept. 22; (96) Sept. 22.
Turbine Station of the Bisbee Improvement Company.* I. A. Rosok. (27) Sept. 22.
Twinvolute Turbine Pumps.* (20) Sept. 22.
The Works of Messrs. Fraser and Chalmers, Limited, Erith, London.* (57) Serial beginning Sept. 23.
The Petrol Engine.* W. Watson. (29) Serial beginning Sept. 23.
Blade Proportioning in Reaction Type Steam Turbines.* Ernest R. Briggs, Assoc. M. Inst. C. E. (12) Serial beginning Sept. 23.
The Testing of Files.* W. Ripper. (Paper read before the Brit. Assoc.) (47) Sept. 23.
Constants and Variables in the Destructive Distillation of Coal.* Alfred H. White and B. M. Ferguson. (Paper read before the Mich. Gas Assoc.) (24) Sept. 26; (83) Oct. 1.
High Sped Compound Engine Design.* J. D. Speeduim. (64) Sept. 27.
Power Required for Rolling Steel.* J. A. Knesche. (9) Serial beginning Oct.
The Locomobile or Superheated-Steam Unit.* Warren H. Miller. (9) Oct.
Koppers By-Product Coke Ovens.* W. E. Hartman. (45) Oct.
Hydraulic Air Compression.* (45) Oct.
Aviation and Aeroplane Motors.* Henri Petit. (Tr. from *La Nature*.) (3) Oct.
Conveyors.* Henry J. Edsall. (10) Oct.
Car Wheel Foundry Practice; Canadian Pacific.* Geo. L. Fowler. (15) Oct. 7.
The Regnard Aeroplane, Automatic Stability of Flying Machines by Means of the Gyroscope.* Paul F. Mottelay. (19) Oct. 8.
Note sur les Tarauds et Filières.* A. Minne. (32) July.
Remarques sur l'Ecoulement des Fluides le Long des Surfaces.* R. Tison. (37) Aug. 31.
Le Dirigeable *Clement-Bayard II.** A. Riester-Picard. (33) Sept. 17.
Neuere Maschinen zur Betonbereitung und Verarbeitung.* (51) Serial beginning Sup. No. 19.
Zur Frage der Geschwindigkeits-Regelung der Turbinen.* Kroner. (97) July 20.
Giessereiflammöfen und ihre Berechnung.* Bernhard Osann. (50) Sept. 7.
Muffelöfen für Emaillierwerke und andere industrielle Zwecke.* Ernst A. Schott. (50) Sept. 7.
Eine neue Theorie des Kreisels und seine Anwendung in der Technik.* A. Fuchs und R. Katzmayr. (48) Serial beginning Sept. 10.
Luftfederhämmer mit bewegtem Zylinder, Bauart Hessenmüller.* U. Lohse. (48) Sept. 17.
Versuche an Rateaugebläsen.* H. Bonte. (48) Oct. 1.
Elektrische Einrichtungen an fahrbaren Verladebrücken.* O. Pollok. (48) Oct. 1.
Einfaches Verfahren zur Ermittlung der Formänderung eben gekrümmter stabförmiger Körper.* R. Baumann. (48) Oct. 1.

Metallurgical.

The Girod Furnace.* W. Borchers. (71) Vol. 81.
The Chemical and Mechanical Relations of Iron, Manganese and Carbon.* J. O. Arnold and A. A. Read. (71) Vol. 81.
Uniform Nomenclature of Iron and Steel. John Oliver Arnold. (71) Vol. 81.
Some Recent Investigations on Case-Hardening.* Sydney A. Grayson. (71) Vol. 81.
The Crystallography of the Iron-Carbon System.* Adolphe Kroll, Jr. (71) Vol. 81.
The Constitution of Cast Irons and Carbon Steels from the Practical Standpoint.* Donald M. Levy. (71) Vol. 81.
Vanadium and Metallurgy. J. Kent Smith and W. L. Turner. (22) Serial beginning Sept. 9.
Pyrite Smelting and Sulphuric Acid Manufacture.* F. J. Falding and J. Parke Channing. (16) Sept. 17.
Experiments with Portland Cement Cupels.* T. P. Holt and N. C. Christensen. (16) Sept. 17.

---

* Illustrated.

Metallurgical—(Continued).

The Influence of Impurities on the Properties of Copper.* F. Johnson. (105) Oct.
The Passing of Crucible Steel.* Joseph W. Richards. (105) Oct.
Electrolytic Copper Refining in Australia. G. H. Blakemore. (Abstract from *Bul.* Australian Inst. Min. Engrs.) (16) Serial beginning Oct. 8.
Siliciures Métalliques Action du Carbure de Silicium sur Quelques Oxydes Métalliques. L. Baraduc-Muller. (93) Sept.

Military.

Redoubts and Field Fortifications.* Wm. D. Connor. (100) Oct.
Die Kugelfallprobe. John J. Schneider. (48) Sept. 24.

Mining.

Concentration Work at Cananea, Mexico.* Courtenay De Kalb. (103) Sept. 10.
Deep Mining in Transvaal.* Roland Gascoyne. (103) Sept. 10.
Surface Plant at Wood Farm Colliery.* (22) Sept. 16.
The South Varanger Iron-Ore Deposits and Separating and Briquetting Plants.* (11) Sept. 16.
Lessons from Gilpin County Practice.* George E. Collins. (103) Sept. 17.
Filter-Pressing Slimes. M. W. von Bernewitz. (103) Sept. 17.
Barometric Pressure and Liberation of Firedamp.* Leon Morin. (16) Sept. 17.
Conditions for Gold Dredging in French Guiana.* Albert Bordeaux. (16) Sept. 17.
Precautions for Maximum Safety and Effectiveness in Value.* (13) Sept. 22.
Refuge Chambers in Coal Mines. George S. Rice, M. Am. Inst. M. E. (Abstract of paper read before the West Va. Coal Min. Inst.) (13) Sept. 22.
The Prevention of Mine Accidents. (Report of Comm. to Amer. Min. Congress.) (16) Sept. 24.
Experiments with Steam and Electric Winding Engines. (From *Glückauf.*) (57) Sept. 30.
Electric Haulage in Collieries and Mines.* (26) Sept. 30.
Timbering in the Joplin District.* Lucius L. Wittich. (45) Oct.
Pumping at Bisbee, Arizona.* C. C. Austin. (45) Oct.
Elliptical *vs.* Rectangular Shafts.* Wm. Archie Weldin. (45) Oct.
Zinc Ore Dressing in Colorado.* H. C. Parmlee. (105) Oct.
Peculiar Water Problem at Candelaria Mines. George A. Laird. (16) Oct. 1.
San Rafael y Anexas Mining Company, Pachuca.* E. Girault. (16) Oct. 1.
Electric Shocks in Coal Mines. Sydney F. Walker. (16) Oct. 8.

Miscellaneous.

Forestry.* L. W. Goodrich. (28) Sept.
Notes on the Humidity of Air. Charles R. Honiball, M. I. M. E. (70) Serial beginning Oct.
Fixation Industrielle de l'Azote Atmosphérique.* E. Lamy. (32) July.

Municipal.

The Maintenance of Roads. John M. Lynch. (104) Serial beginning Sept. 9.
Bituminous Road Work in Germany. (Abstract of report to Assoc. of Tech. Officers of German Cities.) (14) Sept. 17.
A Study into the High Cost of Asphalt Pavement Repairs in Chicago in 1908-9. S. Whinery, M. Am. Soc. C. E. (Abstract of report to Chicago Commr. on City Expenditures.) (86) Sept. 21.
The Foundation and Drainage of Country Roads. Vernon M. Pierce. (14) Sept. 24.
The Westminster New Public Lighting Contract.* (66) Sept. 27.
Work Preliminary to Road Construction and Street Pavement Maintenance. George C. Warren. (Paper read before the Amer. Soc. of Eng. Contrs.) (86) Sept. 28.
Selection of Material and Method of Street Paving. Hector F. Gullan. (Abstract of paper read before the Inter. Road Congress.) (86) Sept. 28.
Bituminous Road Construction. George C. Warren. (Paper read before the Inter. Road Congress.) (86) Sept. 28.
Wooden Block Pavement Tests in Minneapolis, Minn.* D. M. Avey. (60) Oct.
The Art of Laying Out Cities.* F. Bottge. (10) Oct.
Effect of Lightning on Reinforced Concrete Sidewalks.* Charles Keller. (100) Oct.
City Design and Transportation.* M. Wattman. (Abstract of Report to Inter. Street and Interurban Ry. Assoc.) (17) Oct. 1.
Protective Coatings for Roads in Massachusetts. Austin B. Fletcher, M. Am. Soc. C. E. (Paper read before the Inter. Road Cong.) (14) Oct. 1.

---

* Illustrated.

Municipal—(Continued).

Dustless Roads in Europe. Arthur H Blanchard. (Paper read before the National Good Roads Convention.) (14) Oct. 1; (86) Oct. 5.

Dustless Roads of California. Austin B. Fletcher, M. Am. Soc. C. E. (Paper read before the National Good Roads Convention.) (14) Oct. 8; (86) Oct. 5.

Cost of Rural Road Building in Peel County, Ontario. C. R. Wheelock. (96) Oct. 6.

Continuous and Systematic Road Maintenance. S. Percy Hooker. (Paper read before the National Good Roads Convention.) (14) Oct. 8.

Rectification d'une Route Nationale Exécutée comme Chemin Vicinal dans l'Aveyron.* Daudoux. (43) July.

Balayeuse Automobile, Système Verschuren.* (34) Sept.

Railroads.

Report on Locomotives and Rolling Stock of Narrow-Gauge Light Railways. (Subject for discussion at the 8th Railway Congress.)* Moriz Jesser. (88) July.

Report (Russia) on Strengthening the Bridges with a View to Increasing the Weight of Locomotives and the Speed of Trains. (Subject for discussion at the 8th Railway Congress.)* N. Bélélubsky and N. Bogouslawsky. (88) July.

Note on the Double Application of the M. D. M. Automatic Route-Combiner to the Hydraulic Operating Gear and to the Interlocking of the Points and Signals at the Landy Signal Cabins, near Paris, by the French Northern Railway.* A. Moutier. (88) July.

Report on the Operation of Switches and Signals. (Subject for discussion at the 8th Railway Congress.)* L. Weissenbruch and J. Verdeyen. (88) July.

Inaugural of the New York Extension of the Pennsylvania Railroad: Opening of the Passenger Station.* (13) Sept. 15; (27) Sept. 15; (18) Sept. 10.

Improvements and Experiments in Rail Joints. (13) Sept. 15.

Railway Signaling. J. A. Whyte. (96) Sept. 15.

Grading Work on the C. N. O. Railway, Toronto-Ottawa Line.* (96) Sept. 15.

The Modern Locomotive Repair Shop.* A. D. Porter. (96) Sept. 15.

General Specification for Railway Construction. (96) Sept. 15.

The Electrification of Steam Roads.* R. R. Keely. (96) Sept. 15.

Interurban Railways Centering in Toronto.* (96) Sept. 15.

New French Pacific Express Engine, Chemin de Fer du Midi.* (12) Sept. 16.

On the Use of an Accelerometer in the Measurement of Road Resistance and Horse-Power.* H. E. Wimperis, Assoc. M. Inst. C. E. (Paper read before the Brit. Assoc.) (12) Sept. 16; (73) Sept. 16.

Rail Corrugation. A. Busse. (Report to the Union Inter. de Tramways et de Ch. de Fer. Local.) (73) Sept. 16; (17) Sept. 17.

Four-Cylinder Compound Locomotive with Superheater "Helicoidal en Cascade."* (18) Sept. 17.

Care of Track Material and Tools.* (Comm. Report to Roadmasters' and M. of W. Assoc.) (18) Sept. 17.

An Economic Comparison of Railway Ties of Different Materials.* Neil N. Campbell. (13) Sept. 22.

The Electric Railways in Germany.* Wilhelm Wechmann. (15) Sept. 23.

Heavy Pacific Type Locomotive for the Vandalia.* (15) Sept. 23; (18) Oct. 1; (25) Oct.

New York City Freight Terminals.* (15) Sept. 23.

Recent Improvements of the Oregon & Washington Railroad.* (14) Sept. 24.

The Destinies of 500-Volt D. C., 1 200-Volt D. C. and 6 600-Volt A. C. Motors. W. E. Davis. (Abstract of paper read before the Central Elec. Ry. Assoc.) (17) Sept. 24.

The Power of a Locomotive Boiler. C. Hugh Sumner, A. M. Inst. C. E. (From *Eng. Review.*) (19) Sept. 24.

Angular Loading-Track Arrangement for Panama R. R. Docks at Cristobal.* E. B. Karnopp. (13) Sept. 29.

An Electric Freight Locomotive for City Lines. (13) Sept. 29.

Telephone Dispatching and Train-Order Signals for Electric Railways. (13) Sept. 29.

Philippine Railway Company Lines.* (Abstract from *Far Eastern Review.*) (15) Sept. 30.

Development of Articulated Locomotives.* C. H. Caruthers. (15) Sept. 30.

Standard Types of Locomotives on the Saxon State Railways.* (21) Oct.

The Railways of the Cape of Good Hope.* (21) Serial beginning Oct.

All Steel Pullman Cars.* (25) Oct.

British Locomotive Development. R. H. Rogers. (25) Oct.

Service of Converted Mallet Locomotive; Great Northern Railway.* (25) Oct.

---

* Illustrated.

Railroads—(Continued).

Powerful Lignite Burner of the Mikado Type; Oregon Railroad and Navigation Co.* (25) Oct.
Low Water Test of a Jacobs-Schupert Fire Box.* (25) Oct.
Some Experience with Reinforced Concrete Poles. (14) Oct. 1.
Signaling at the New Grand Central Terminal.* (15) Oct. 7.
New 60-Ton Locomotives of Illinois Traction Company.* (17) Oct. 8.
Boring through the Bernese Oberland.* (From *The Sphere.*) (19) Oct. 8.
Train Lighting Practice. H. G. Myers. (Abstract of report to Assoc. of Ry. Elec. Engrs.) (18) Oct. 8.
Appareil de Levage pour Grandes Voitures de Chemins de Fer.* A. Berger et C.-J. Van Mierlo. (31) 1910, Pt. 2.
Note sur Divers Types de Stations Souterraines établies dans des Voies Etroites pour le Chemin de Fer Nord-Sud de Paris.* Bechmann. (43) July.
L'Intérêt des Wagons de Grande Capacité. Pierre Arbel. (32) July.
Nouvel Autocombinateur M. D. M. Système Aster, pour la Commande par Fluide et l'Enclenchement des Aiguilles et des Signaux mis en Service à la Gare de Paris-Nord.* Paul Aumont. (38) Sept.
Essais Effectués avec les Dernières Locomotives Compound à Quatre Essieux Couplés et à Bogie de la Compagnie P. L. M.* Vallantin. (38) Sept.
Les Locomotives Françaises et Etrangères à l'Exposition de Bruxelles de 1910.* L. Pierre-Guédon. (33) Serial beginning Sept. 3.
La Station Expérimentale du Froid de Chateaurenard (Bouches-du-Rhône).* E. Lemaire. (33) Sept. 24.
La Construction des Grands Tunnels de Montagne d'après les Résultats Obtenus au Simplon.* Brandau. (Abstract from *Schweiz. Bauzeitung.*) (33) Sept. 24.
Die selbsttätige Gleisklemme gegen das Wandern der Schienen.* Morgenstern. (102) Serial beginning Sept. 1.
Kennzeichnung des Zugschlusses auf drei nebeneinander laufenden Linien.* Platt. (102) Sept. 1.
Die Durchschlagsgeschwindigkeit bei den Luftsauge-und Druckluftbremsen.* Karl Kobes. (53) Sept. 2.
Ueber Schienenstahl.* Pierre Breuil. (Abstract of paper read before the Inter. Congress at Düsseldorf.) (50) Sept. 14.
Die Eisenbahnbetriebsmittel auf der Brüsseler Weltausstellung.* C. Guillery. (102) Sept. 15.
Prellbock mit Schlepprost von Rawie.* Stieler. (102) Sept. 15.
Eine neue Schwarzwaldbahn Weisenbach-Forbach.* Gaber. (51) Serial beginning Sept. 17.

Railroads, Street.

Repair Shops of the Bangor Railway & Electric Company.* (17) Sept. 24.
Methods of Conducting the Valuation of the Physical Properties of the Chicago Consolidated Traction Co., with Summaries of Costs. Philip J. Kealy. (86) Serial beginning Sept. 28.
The Comparative Durability of Brake Shoes and Tyres.* J. W. Dawson. (Abstract of paper read before the Mun. Tramways Assoc.) (73) Sept. 30.
Note sur l'Exécution de la Station du Chemin de Fer Métropolitain de Paris, "Rue de Crimée."* Suquet. (43) July.

Sanitation.

The Contamination of City Air.* George A. Soper. (Paper read before the Bost. Soc. of Civ. Engrs.) (1) Aug.
Drain Tile and Underdrainage.* C. G. Elliott, M. Am. Soc. C. E. (76) Sept.
The Sewage Question and Treatment of Trade Effluents. John D. Watson, M. Inst. C. E. (Paper read before the Royal San. Inst.) (104) Sept. 16; (14) Oct. 1.
Sewage Purification at Frome.* (104) Sept. 16.
Preservation of Sewage by Chloroform and Cold Storage. (14) Sept. 17.
Gravity Steam Heating of a Hospital.* Chas. L. Hubbard. (101) Sept. 17.
Modern Practice in Garbage Disposal. Rudolph Hering. (Paper read before the Amer. Public Health Assoc.) (14) Sept. 24.
Sewage Disposal under Difficulties at Leicester, England.* (13) Sept. 22.
Trenching for a Sewer using a Grab Bucket Excavator, with Some Data on the Concrete Work.* (86) Sept. 28.
Methods of Garbage Collection and Disposal in the Canal Zone, Panama and Colon. (From the *Canal Record.*) (86) Sept. 28.
Modern Procedure in District Sewer Design.* W. W. Horner. (13) Sept. 29.
Heating and Ventilating the Gimbel Building, New York.* (70) Oct.
The Mechanical Purification of Air. C. L. Browne. (10) Oct.
Ground Water Leakage into Sanitary Sewers. E. D. Rich. (Abstract from *Mich. Technic.*) (14) Oct. 1.

---

* Illustrated.

Sanitation—(Continued).

Grease Extraction from Sewage Sludge at Oldham. L. St. G. Wilkinson. (Abstract of paper read before the Royal Inst. of Public Health.) (14) Oct. 1.
Economy in Sewage Disposal. C. Chambers Smith, M. Inst. M. C. E. (Paper read before the Royal San. Inst.) (96) Oct. 6.
The Salt Lake Sewage Pumping Station.* (14) Oct. 8.
School Fan Furnace-Heating Plant.* (101) Oct. 8.
Notice sur l'Epuration Biologique des Eaux d'Egout sur Sol Artificiel.* A. Loewy. (43) July.
Das Aufstellen von Typenreihen im Ventilatorenbau. Vidmar. (97) Serial beginning July 5.

Structural.

The Elastic Breakdown of Certain Steels.* C. A. M. Smith. (71) Vol. 81.
The Homogeneity of Metals.* Gregory Tagueeff. (71) Vol. 81.
The Cutting Properties of Tool Steel.* Edward G. Herbert. (71) Vol. 81.
Ninth Report to the Alloys Research Committee; on the Properties of Some Alloys of Copper, Aluminium, and Manganese.* W. Rosenhain and F. C. A. H. Lantsberry. (75) Jan.
Some Physical Properties of Two Per Cent. Chromium Steels. Andrew McWilliam and Ernest J. Barnes. (71) Vol. 81.
The Calcium Silicates and Calcium Aluminates Contained in Portland Cement. O. Schott. (Tr. by W. Michaelis, Jr.) (67) Sept.
Method of Jetting down Concrete Piles and Records of Output.* (86) Sept. 14.
Exterior Treatment of Concrete Surfaces: Committee Report to the National Association of Cement Users. (13) Sept. 15; (14) Sept. 24.
Fifth Avenue Retaining Wall; Oregon & Washington, Seattle, Wash.* (15) Sept. 16.
The Testing of Heat-Insulating Materials.* Frederic Bacon, A. M. I. E. E. (Paper read before the Brit. Assoc.) (11) Sept. 16; (73) Sept. 16.
Reinforced Concrete for Chimney Construction. P. S. Sheardown. (Abstract of paper read before the Tramways and Light Rys. Assoc.) (73) Sept. 16.
The Heat-Treatment of Brass.* G. D. Bengough and O. F. Hudson. (Paper read before the Inst. of Metals.) (11) Sept. 23.
Structural Details in the Wick Building, Youngstown.* (14) Sept. 24.
Methods and Cost of Placing Concrete in Long Wall by Chutes.* (86) Sept. 28.
Construction Methods on a Concrete Standpipe.* (96) Sept. 29.
American Ingot Iron, its Development and Production.* George L. Fowler. (15) Sept. 30.
Hardness and its Measurement.* G. A. Roush. (105) Oct.
Fireproof Building Construction. E. T. Cairns. (8) Oct.
Automatic Sprinkler Protection.* E. P. Boone. (8) Oct.
Modern Practice in Factory Construction from a Fire Protection Standpoint. William D. Grier. (8) Oct.
Erection of the Substructure of the Pennsylvania Terminal Post Office.* (14) Oct. 1.
The Municipal Pipe Yard at San Francisco.* (14) Oct. 1.
The Production of Concrete Pipes by Centrifugal Action.* Alfred Gradenwitz. (46) Oct. 1.
Methods of Constructing a Reinforced Concrete Water Tower Using Steel Forms and Movable Steel Staging.* (86) Oct. 5.
Tests of Reinforced Concrete Slabs.* (13) Oct. 6.
The Deformation of a Four-Sided Hopper. Clyde T. Morris, M. Am. Soc. C. E. (13) Oct. 6.
Method of Designing a Long Span Concrete Girder. (86) Oct. 6.
Unusual Foundations for a Twelve-Story Building.* (14) Oct. 8.
Structural Improvements in a Large Stable.* (14) Oct. 8.
Versuche mit zentrisch und mit exzentrisch belasteten Pfeilern aus Backsteinmauerwerk und aus Beton.* C. Bach. (48) Sept. 24.

Water Supply.

The Application of the Pitot Tube to the Testing of Impulse Water-Wheels. William Rankine Eckart. (75) Jan.
An Account of a Visit to the Power Plant of the Ontario Power Co. at Niagara Falls.* C. W. Jordan. (75) Jan.
Secondary Water Supplies, their Dangers and Values.* (28) Sept.
Sterilization of Polluted Water by Ultra-Violet Rays.* Kenneth C. Grant, Assoc. M. Am. Soc. C. E. (13) Sept. 15.
A Sterilization Plant for Turbid Water.* (14) Sept. 17.
Operating Results, St. Louis Coagulating Works. (14) Sept. 17.
Concrete Lining of the Rondout Pressure Tunnel.* (14) Sept. 17.
Hypochlorite Treatment of Public Water Supplies; its Adaptability and Limitations. George A. Johnson. (Paper read before the Amer. Pub. Health Assoc.) (14) Sept. 17.

---

* Illustrated.

Water Supply—(Continued).

Operating Results of the Albany Filters. (14) Sept. 17.
The Ancient Irrigation and Water-Supply Tanks or Reservoirs of Ceylon.* W. G. Bligh, M. Inst. C. E. (13) Sept. 22.
Progress of the Great Barren Jack Dam in Australia. (12) Sept. 23.
Slow Sand Filters at Oakland Lake, Long Island, N. Y.* (14) Sept. 24.
Concrete-Lined Reservoirs in Seattle.* (14) Sept. 24.
Operating Results of the Bubbly Creek Filter Plant, Chicago.* C. A. Jennings. (14) Sept. 24.
Reinforced Concrete Water Tower at Westerly, R. I.* (14) Sept. 24.
Plant of the Holton Power Company.* Howard H. Bliss. (64) Sept. 27.
Operating Costs at the St. Louis Coagulating Works. (86) Sept. 28.
Discharge Measurements and Formulas for Some Large Overflow Dams.* W. F. Martin, Assoc. M. Am. Soc. C. E. (13) Sept. 29.
Quality of Lake Michigan as a Water-Supply for the North Shore District. Langdon Pearse, Assoc. M. Am. Soc. C. E. (Abstract of paper read before the North Shore San. Assoc.) (13) Sept. 29.
Hydroelectric Development on the Illinois River.* (27) Sept. 29.
North Toronto Water Supply and Hypochlorite Treatment. E. A. James. (96) Sept. 29.
Practice in the Use of Hypochlorite of Lime. H. E. Jordan. (96) Sept. 29.
A New Recording Loss-of-Head Gage for Sand Filters.* F. B. Leopold. (13) Sept. 29.
Tunneling on Los Angeles Aqueduct.* R. L. Herrick. (45) Oct.
The Mechanical Filter Plant at Wilkinsburg.* (14) Oct. 1.
New Central Reservoir of the People's Water Company.* L. L. Mills. (14) Oct. 1.
The Filter Plant at Helsingfors, Finland. E. A. Gieseler, C. E. Berlin. (14) Oct. 1.
Results of Experiments on Double Filtration at the Albany, N. Y., Water-Works. Wallace Greenalch. (Abstract from Annual Report, Bureau of Water, Albany, N. Y.) (86) Oct. 5.
The Acid Waters of Western Pennsylvania.* E. C. Trax. (Abstract of paper read before the Central States W. W. Assoc.) (13) Oct. 6; (14) Oct. 1.
The Design and Construction of the St. Andrews Movable Dam and Lock on the Red River at Lockport, Manitoba.* Edwin A. Forward. (13) Oct. 6.
Sherbrooke Power Plant.* C. B. Woodyatt. (86) Oct. 6.
The Hudson River Siphon Crossing of the Catskill Aqueduct. (14) Serial beginning Oct. 8.
The Water Works of Hankow, China. (14) Oct. 8.
An Arched Dam at Las Vegas, New Mexico.* (14) Oct. 8.
The Las Vegas Irrigation Project, New Mexico.* H. H. Barnett. (14) Oct. 8.
Décolmateur à Succion pour le Nettoyage des Préfiltres à Sable.* (33) Sept. 3.
L'Usine Hydro-Electrique de Tuilière et la Distribution de l'Energie Electrique dans le Sud-Ouest de la France.* A. Dumas. (33) Sept. 10.
Versuche über die Umsetzung von Wassergeschwindigkeit in Druck.* (48) Serial beginning Sept. 17.

Waterways.

East Side Levee and Sanitary District, East St. Louis.* (14) Sept. 17.
Novel Submarine Concrete Work.* Frank C. Perkins. (19) Sept. 17.
A Concrete Bulkhead Wall on Piles.* (14) Sept. 17.
Construction Plant and Methods for Building an 85 000 Cu. Yd. Rubble Concrete Dam.* (86) Sept. 21.
An Economical Method of Using a Movable Form for Long Concrete Walls, with Some Costs (Barge Canal).* (86) Sept. 21.
New York City Freight Terminals.* (15) Sept. 23.
Siphon Spillways New York State Barge Canal.* (86) Sept. 28.
Separately-Molded Sections for a Concrete Sea Wall.* (Abstract from *Concrete and Constructional Eng.*) (13) Sept. 29.
Locks and Dams of the Panama Canal.* (12) Serial beginning Sept. 30.
Recent Progress at Panama.* Fullerton L. Waldo. (9) Oct.
Rock Excavation at Rock River Pool.* (100) Oct.
Rebuilding the Galena Lock Gates.* S. Edwards. (100) Oct.
The Baltimore Light-House.* W. E. Craighill. (100) Oct.
Siphon Spillways on the Champlain Canal.* (14) Oct. 8.
Phare avec Signal Acoustique sans Gardien au Large de Saint-Pierre (Ile de Guernesey).* (33) Sept. 3.

---

* Illustrated.

Vol. XXXVI. OCTOBER, 1910. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

CONTENTS

Papers:

PAGE

Bond-Friction-Resistance in Reinforced Concrete.
By WILLIAM FRY SCOTT, Assoc. M. Am. Soc. C. E. 1244

Two Reinforced Concrete Coal Pockets.
By MYRON S. FALK, M. Am. Soc. C. E. 1281

Discussions:

Remedies for Landslides and Slips on the Kanawha and Michigan Railway.
By CHARLES H. MILLER, M. Am. Soc. C. E. 1289

The Tieton Canal.
By HORACE W. SHELEY, Assoc. M. Am. Soc. C. E. 1291

Rust, as Shown in the Removal of a Seventeen-Story Building.
By E. L. VERVEER, Assoc. M. Am. Soc. C. E. 1294

Memoirs:

WILLIAM FOSTER BIDDLE, M. Am. Soc. C. E. 1296
CLARENCE ALLEN CARPENTER, M. Am. Soc. C. E. 1297
GEORGE EARL CHURCH, M. Am. Soc. C. E. 1299
WILFRED EMORY CUTSHAW, M. Am. Soc. C. E. 1301
CHARLES DAVIS, M. Am. Soc. C. E. 1304
IRVING TUPPER FARNHAM, M. Am. Soc. C. E 1305
DANIEL FARRAND HENRY, M. Am. Soc. C. E. 1307
GEORGE ANTHONY LEDERLE, M. Am. Soc. C. E. 1310
JOHN EGBERT MCCURDY, M. Am. Soc. C. E. 1311
WILLIAM ANSON PEARSON, JR., M. Am. Soc. C. E. 1312
ARCHIBALD ALEXANDER SPROUL, JR., M. Am. Soc. C. E. 1313
RICHARD FENWICK THORP, M. Am. Soc. C. E. 1315

PLATES

Plate CLXIX. Diagram Showing Ultimate Bond-Friction-Resistance on Plain Rods and Bars 1267
Plate CLXX. Section, Floor Plan, etc., Coal Pocket No. 1 1283
Plate CLXXI. Reinforcement for Coal Pocket No. 1 1285
Plate CLXXII. Views of Coal Pocket No. 1 1285
Plate CLXXIII. Forms for Concreting, Coal Pocket No. 2 1287
Plate CLXXIV. View of Coal Pocket No. 2 and Conveyor 1287

Vol. XXXVI. OCTOBER, 1910. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

BOND-FRICTION-RESISTANCE IN REINFORCED CONCRETE.

By William Fry Scott, Assoc. M. Am. Soc. C. E.

To be Presented December 7th, 1910.

Early in 1907 the writer began a systematic study of bond in reinforced concrete in flexure. This study was particularly directed to the published reports of experiments by eminent American investigators on reinforced concrete. The reports on hand at the time the study began were by Professors Hatt, Lanza, Talbot, Howe, Turneaure, and Marburg, and Messrs. Humphrey, Harding, and others. Later, further reports were obtained from the Universities of Illinois and Wisconsin. The files of *Engineering News, Engineering Record,* and *Concrete Engineering* were carefully scrutinized, and other publications were examined for data on this subject.

As a result of this investigation the writer has proven that the usual assumption that reinforced concrete is "practically a homogeneous material" is not true, and it follows from this that sectional planes before bending do not remain plane surfaces after bending.

The method of analysis pursued by the writer, though not along strictly conventional lines, as laid down in the current literature on the mechanics of a reinforced concrete beam, was nevertheless mathematically correct. A reinforced concrete beam is not like a timber girder or a steel beam. It is a really wonderful combination of two unlike materials, each having properties when alone that are not at

---

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings,* and, when finally closed, the papers, with discussion in full, will be published in *Transactions.*

all in evidence when the two materials are combined. Further, there are no precedents in the history of the mechanics of materials for such a combination.

The following is a brief synopsis of the mechanics of the beam as adapted to this study:

The bending moment produced on a beam by external forces is resisted by an equal and opposing moment which is developed in the beam—this is the section moment. If a transverse section is made through a beam, the action of the portion to the right on the portion to the left may be reduced to two equal forces, one positive and the other negative, which two form a couple the arm of which is the distance between their respective points of application. The point of application for the former will be the centroid of the compressive stresses; and of the latter, the center of the steel. Manifestly, the force acting on the steel in one direction, say, to the right, is equal to the friction force operating to the left between the steel and the surrounding concrete. This latter force is usually called "bond," but, as the real bond is broken at a very low stress compared with the final resistance at failure, and, as a kind of friction-resistance ensues after the bond is broken, it has been considered better to call it bond-friction-resistance. This bond-friction-resistance, therefore, may be defined as a friction force which operates after incipient movement has taken place. The intensity of the tensile stress that can be developed in the steel at a cross-section is mainly dependent on this bond-friction-resistance.

The following formulas have been used:

$$M_b = M_s = f_s \, A_s \, d' = f_b \, \Sigma O \, l' \, d',$$

in which M_b is the bending moment,

M_s is the section moment,

f_s is the unit stress in the steel,

A_s is the total area of the cross-section of the steel,

d' is the distance from the center of the reinforcement to the centroid of compressive stresses,

f_b is the average value for bond-friction-resistance per unit area of surface of rods to, say, the left of the cross-section;

ΣO is the sum of the perimeters of either round or square rods,

and, l' is the entire length of the encased portion of the rod to the left of the cross-section.

The following is a short history of the various steps leading to the final results that have been developed from this investigation:

The first phenomena noted were: that perfect bond between the concrete and the surface of the steel did not seem to be very lasting; that, after the real bond was broken, there was a creeping of the rods accompanied by a frictional resistance between the particles adhering to them and the rough surface of the concrete encasing them; and, that, in cases of repeated loading, after the load had been taken off, the rods would not always return to their original position—evidently having been stopped in their return because loosened particles of the concrete turned sufficiently to wedge in and prevent it.

SLIPPING OF RODS IN REINFORCED CONCRETE.

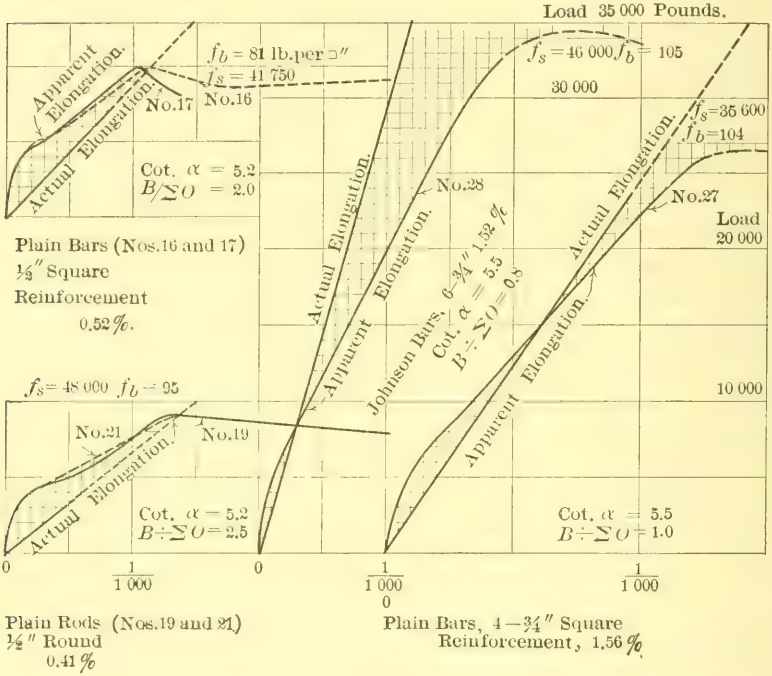


Fig. 1.

The slipping of rods is shown on Figs. 1 and 2. The group of beams in Fig. 1 is from Talbot's series of 1904. The group in Fig. 2

is from Lanza's series.* The apparent elongation was observed by extensometers in the Talbot series, and by direct readings in the Lanza series. The actual elongation was computed from the known value of the modulus of elasticity of the steel and from the value of

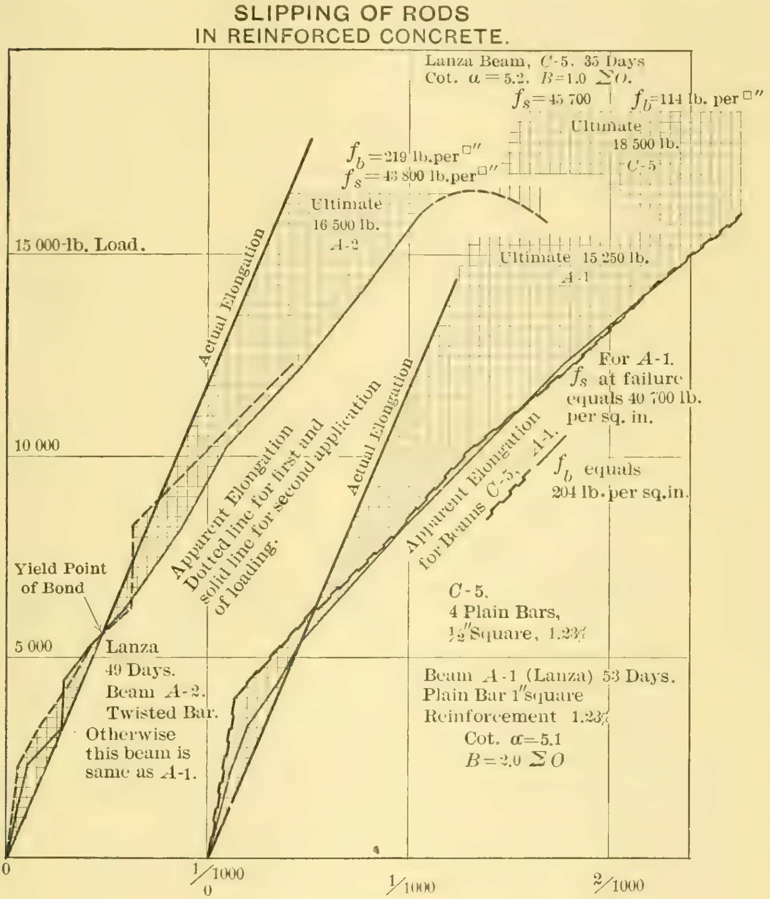


FIG. 2.

the tension produced therein, as calculated from the known forces acting on the specimen.

The Talbot beams, Nos. 27 and 28, were practically alike, with the exception that one was reinforced with plain bars and the other with deformed bars. The creeping seems to have begun on No. 28 (deformed-bar reinforcement) at about one-fourth of the ultimate load, and to have increased to nineteen-elevenths (1.72) of the actual elongation of the steel at the reading taken immediately before failure. This implies an apparent slip of 72% of the actual elongation. This point, where the creeping seems to have begun, may be called the yield point of the bond, and, for all practical purposes, may be taken as the point of intersection of the curves for actual and apparent elongation of the steel. On No. 27 (plain-bar reinforcement) the creeping seems to have begun at about two-thirds of the ultimate load, and the apparent elongation at the reading taken before failure was about $12 \div 10\frac{1}{2}$ (1.14) of the actual. This implies an apparent slip of only 14% of the actual elongation.

---

* Reports on both these series may be found in *Proceedings*, Am. Soc. for Testing Materials, Vol. VI.

The Lanza beams, *A*-1, *A*-2, and *C*-5, in Fig. 2, are very much like the Talbot beams, Nos. 27 and 28, as to make-up and quality, with a very slight variation as to age. On *A*-2 (deformed-bar reinforcement) the creeping seems to have begun at about one-third of the ultimate load, and the apparent elongation at the reading taken before failure was $22 \div 13\frac{1}{2}$ (1.63) of the actual. This implies an apparent slip of 63% of the actual elongation. On *A*-1 (plain-bar reinforcement) the creeping seems to have begun at one-third of the ultimate load, and the apparent elongation at the reading taken before failure was $22\frac{1}{2} \div 12$ (1.88) of the actual. This implies an apparent slip equal to 88% of the actual elongation. On *C*-5 (plain-bar reinforcement) the creeping seems to have begun at about one-third of the ultimate load, and the apparent elongation at the reading taken before failure was $26\frac{1}{2} \div 13\frac{1}{4}$ (2.0) of the actual. This implies an apparent slip equivalent to the actual elongation of the rod.

Before considering the Talbot beams, Nos. 16, 17, 19, and 21, it is desirable to define the exact meaning of "apparent elongation." The apparent elongation, which is observed on the side of the beam, is transmitted from the rod to the face of the concrete by the intervening concrete. It is fair to assume:

First.—That the strain transmitted to the intervening concrete by the rod must (when the bond is not broken) be a maximum on the fibers next to the surface of the rod, and zero at some point remote therefrom in the horizontal plane of the steel.

Second.—That that point may fall (*a*) on the surface of the beam, (*b*) between the surface of the beam and the surface of the rod, or (*c*) entirely outside of the surface of the beam. If the zero point falls within, then none of the strain (unless possibly of a negative nature) will reach the surface of the beam; on the other hand, if it falls without, then a certain proportion of the strain will reach the surface. In the above statements it will be recognized that the writer does not accept without question the historic assumption regarding plane sections in reinforced concrete beams.

Third.—Another circumstance that will also be apparent is the fact that, after the ultimate tensile strength of the concrete has been exceeded, the horizontal fibers of this material begin to tear apart and form irregular divisions along the tensile side of the beam.

It is conceivable that the bond may be preserved in some of these divisions, and more or less transformed to bond-friction-resistance in others. Some of the slip may be taken up in visible tension cracks and some by a number of microscopic cracks distributed in each of these divisions, but, as the load increases, these will tend to close and localize the elongation in a few definite fractures, more particularly those under the load or loads. The closing of the microscopic cracks will tend to hide most of the real elongation on that division if it should happen that readings are confined to that region. This is particularly true for the middle third of a beam with third-point load. That there is a true elongation in the steel, other than the apparent, may be inferred from the indications in the elongations for the Talbot beams, Nos. 16, 17, 19, and 21, and from the indications resulting (before creeping begins) from repeated loadings on the same beam, or from the first loadings on like beams. The apparent elongation was not even equal to the actual elongation when the maximum load was on beams Nos. 16, 17, 19, and 21. It was ten-elevenths for No. 17, and about the same for the others.

This is what occurred: The true elongation did not happen to appear on the surface within the region measured. It was in evidence, in an irregular way, outside of that region. The apparent elongation also for the second application of load for *A*-2 suggests that there is an elongation other than the apparent. This is evident when the apparent elongations for the first and second applications of load are compared, and is suggested by their relatively erratic behavior below the yield point.

The fact that, in cases of repeated loading, the rods would not always return to their original positions when the load was removed is made evident in the diagrams for deflection of beams tested with repeated loads by Professor Hatt.* This slipping and creeping of the reinforcement, although interesting and not without importance in itself, had only a secondary bearing on the analysis of the tests which follow. The same is the case with the question of plane sections before and after bending.

After several hundred beams had been analyzed, an attempt was made to divide them into groups, as to age and quality of concrete, but—other things being equal—it was observed:

I.—That, as the load on like beams approached the supports, the bond-friction-resistance increased;

II.—That, under no circumstance was there any indication of the high bond values that had been obtained from early experiments on bond by pulling rods from cubes of concrete;

III.—That those beams having a maximum of concrete between the rods gave very high results; and,

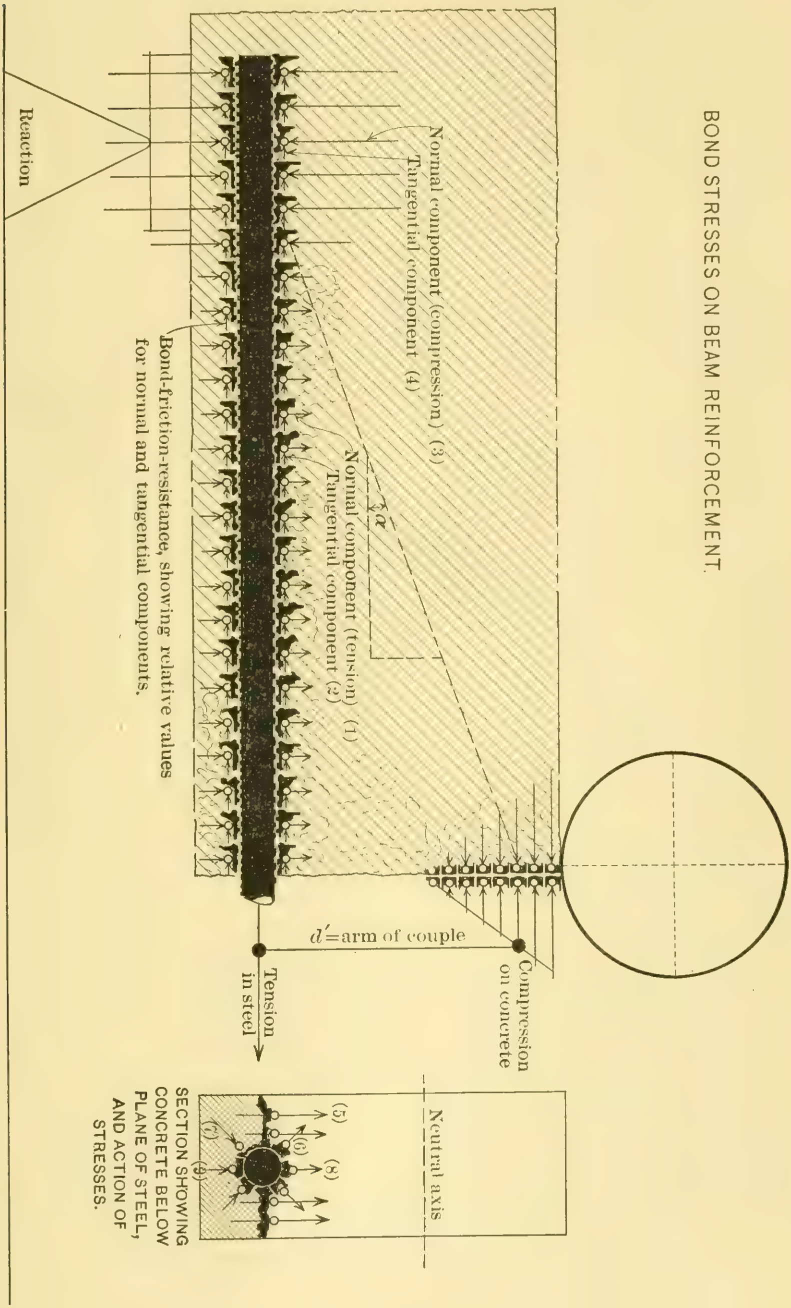
IV.—That those beams with a minimum of concrete between the rods gave very low results.

The first and second observations led to the belief that there must be two components in the bond-friction-resistance, a tangential and a normal component, and to the further beliefs that the normal component in the cases of pulling rods from cubes or cylinders of concrete was a compressive stress; that the normal component in beam tests was mostly tension, with more or less compression at and near the supports; and that this compression at and near the supports varied with the variations of the angle, a, shown in the diagram, Fig. 3. In the section of this diagram showing concrete below plane of steel, the values of the forces (7) and (9), are dependent on the values of (5). This section will also suggest the reason for the sense of the forces acting on the lower side of the rod. In this diagram will also be found further illustration of the distribution of the stresses just mentioned.

The reports, therefore, were all examined again and analyzed with

---

* *Proceedings*, Am. Soc. for Testing Materials; also published in *Engineering News*, October 24th, 1907.


BOND STRESSES ON BEAM REINFORCEMENT.

Reaction
Normal component (compression) (3)
Tangential component (4)
Normal component (tension) (1)
Tangential component (2)
α
Bond-friction-resistance, showing relative values for normal and tangential components.
d′=arm of couple
Tension in steel
Compression on concrete
Neutral axis
(5)
(6)
(7)
(8)
(9)
SECTION SHOWING CONCRETE BELOW PLANE OF STEEL, AND ACTION OF STRESSES.

Fig. 3.

reference to these four elements. Groups were carefully sought which would have not more than one variable the influence of which it was desired to study. Although choosing from more than a thousand experiments, it is surprising how few of them it was possible to place in each group and keep free from foreign influences. However, the material was gradually gathered until sufficient information was obtained as to the influence of each element.

The first hint that the bond-friction-resistance increased as the loads approached the end supports of a beam was gained from a small group of experiments* in which the beams were identical in every way; dimensions of cross-section, length, span, reinforcement, depth of reinforcement, quality of concrete, and age at testing, were as nearly alike for all specimens as could be obtained in laboratory work. The only variable was the position of the load. The group was peculiarly fascinating to the writer, as it held some confusing contradictions. When the load was nearest the supports, the highest values for bond-friction-resistance were developed, yet when it was farthest from the supports, the highest values were developed for the tensile strength of the steel. This group did not seem to be sufficiently representative, but when Bulletin No. 14, from the same Experiment Station, came out with another group, identical in every way and giving results that agreed in every particular with it, the evidence seemed to be conclusive. However, further search was made, and quite an elaborate group was found in Bulletin No. 148 of the University of Wisconsin. The beams in this group were identical as to shape, size, span, and age; they were not as large as those tested in the University of Illinois, nor was the span as great. At the latter station the cement was measured by loose volume, but it was weighed at the University of Wisconsin, 100 lb. being rated as a cubic foot. The other materials were measured by loose volume at each station. The reinforcement in the first two groups was straight round rods without hooks, crooks, deformations, or web members. In the latter group the rods were also round, but they were bent up at various points. The influence of this bending, however, does not affect the comparative values resulting from the influence of position of load. The results from this group confirmed exactly those from the first two groups.

---

* Bulletin No. 4, University of Illinois, Engineering Experiment Station.

That is, there was high bond-friction-resistance when the load was near the supports and lower values as it moved toward the center of the beam. Evidently, the high values that result when the load is near the support are due to an increase in the value of the normal component of the bond-friction-resistance. For each group the length of the arm of the couple which forms the section moment on the cross-section under the load point is constant for every position of the load, therefore the only variable is the distance of the load from the support.

The ratio of these two lengths, therefore, will give an accurate value as a basis for determining the influence of this normal component as affected by the position of the load with reference to various dimensions of beams and various percentages of reinforcement. The variations of this ratio are represented by the cotangent of the angle, a, as abscissas on the diagrams, and the bond-friction-resistance as ordinates. The individual values for each beam and the mean values for like beams are both given for all three groups. The results are plotted on Figs. 4 and 5. It is believed by the writer that this bond-friction-resistance as given on these diagrams is only an average value, and that the true value varies at several points along the rod. At and near the supports it will be almost as great as is obtained from pulling a rod from a cube or cylinder of concrete, in which case the normal component is a compressive force. Outside the influence of the compressive forces acting on the beam, that is, within the influence of the tensile forces, it will be less than the average value given in these diagrams.

Bond-friction-resistance on steel with a high elastic limit, but stressed very much below it, will be higher, probably 3 or 4%, than on steel with a low elastic limit, but stressed a little beyond that limit —other things being equal.

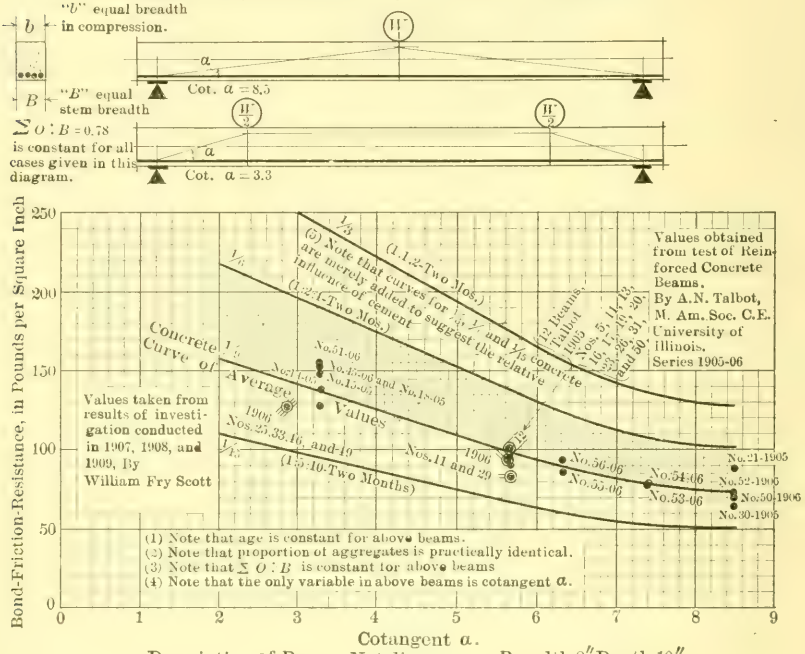
As to the second observation, "that under no circumstance was there any indication of the high bond values that had been obtained from early experiments on bond by pulling rods from cubes or cylinders of concrete," the results of the most important tests on adhesion, as given by Turneaure and Maurer,* indicate that plain bars develop from 237 to 756 lb. per sq. in. for 1:2:4 concrete under such methods, while Fig. 13 indicates that plain bars develop from 50 to 110 lb. for 1 : 2 : 4 concrete when embedded in a reinforced concrete beam with a breadth of stem equal to two-thirds of the sum of their perimeters, as explained later.

---

* "Principles of Reinforced Concrete Construction."

Since this investigation was completed, there have been published* the results of two sets of experiments which are interesting as further confirmation of this second observation. The first is entitled "Tests on Bond in Reinforced Concrete Beams," by Mr. Morton O. Withey, made in the Materials Testing Laboratory at the University of Wisconsin. The second is entitled "Some Tests of Bond of Steel Bars Embedded in Concrete by Three Methods," by Mr. H. C. Berry, made in the laboratory of the Civil Engineering Department of the University of Pennsylvania. The conclusions of Messrs. Withey and

BOND-FRICTION-RESISTANCE
WHEN COTANGENT α IS THE ONLY VARIABLE.

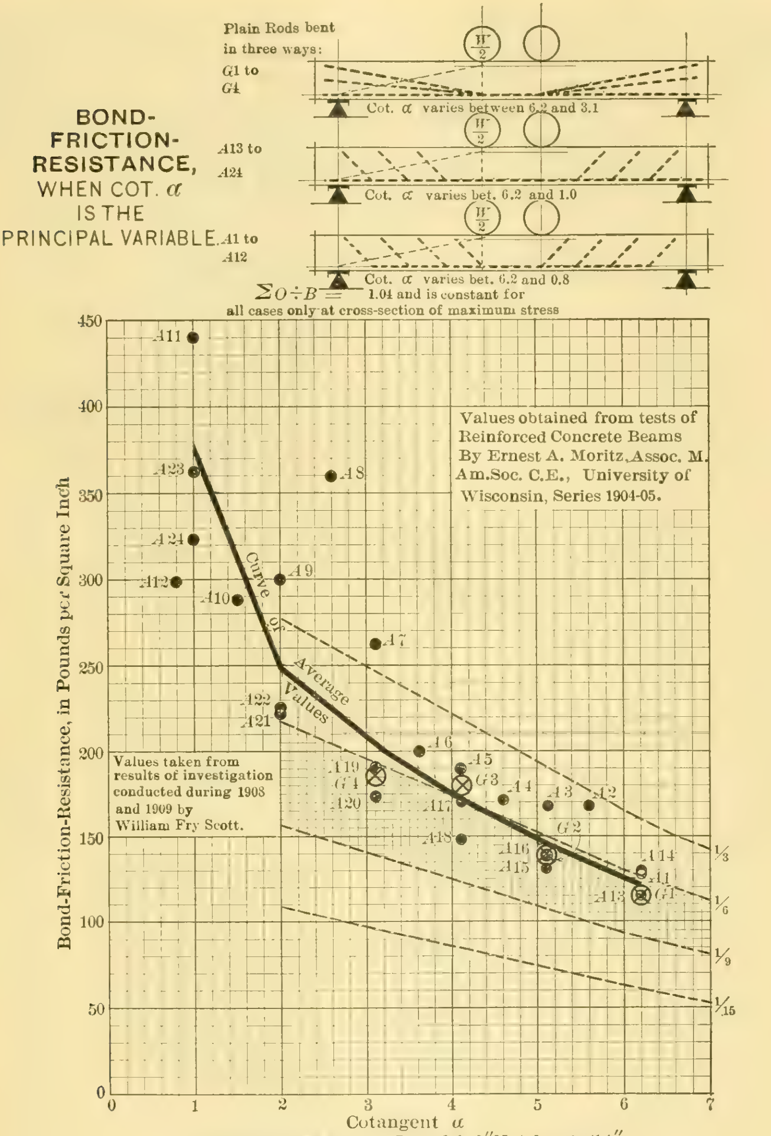


Description of Beams: Net dimensions; Breadth 8," Depth 10,"
1905 Series 1:3:6 Concrete, 2 months old,
1906 Series 1:3:5½ Concrete, 2 months old.
Reinforcement: 4 Straight Rods, ½"ϕ.

FIG. 4.

---

* *Proceedings*, Am. Soc. for Testing Materials.



Description of Beams: Breadth 3,″ Net depth 4½″
Gross depth 5,″ length 4′6,″ Span 4′0″
Mortar 1:2½ (Note Cement was weighed, 100 lb. to the cubic foot which would make a mortar equivalent to 1:2 when measured by loose volume, the latter being the method used by Professor Talbot, Univ. of Illinois.)
Reinforcement: 4 Rods, ¼″ ϕ.

Fig. 5.

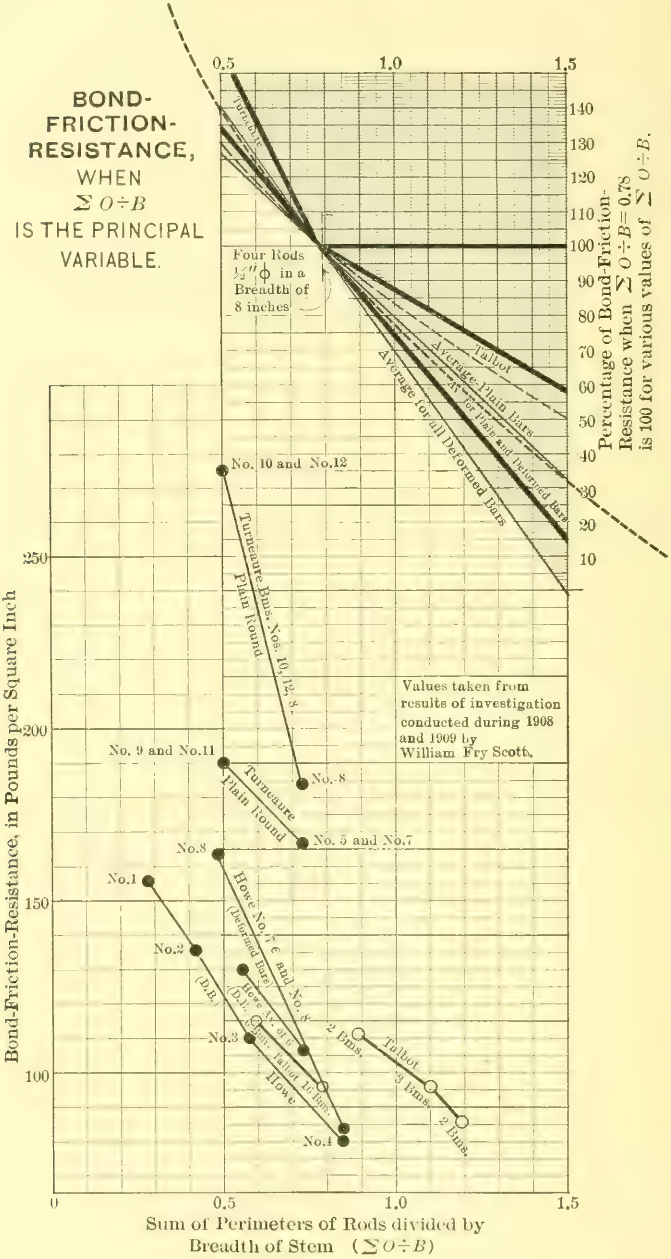
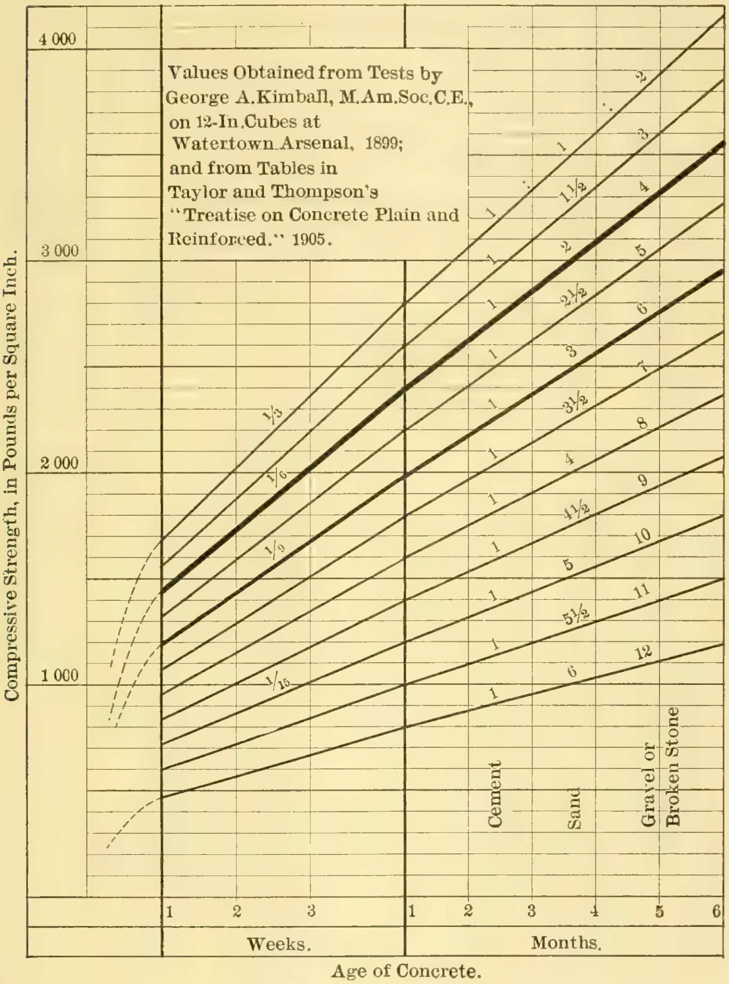

BOND-FRICTION-RESISTANCE, WHEN
Σ O÷B
IS THE PRINCIPAL VARIABLE.
0.5
1.0
1.5
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Percentage of Bond-Friction-Resistance when Σ O÷B = 0.78 is 100 for various values of Σ O÷B.
Turneaure
Four Rods ½″ ϕ in a Breadth of 8 inches
Talbot
Average Plain Bars
Av. for Plain and Deformed Bars
Average for all Deformed Bars
No. 10 and No.12
Turneaure Bms. Nos. 10, 12, 8.
Plain Round
No.-8
Values taken from results of investigation conducted during 1908 and 1909 by William Fry Scott.
No. 9 and No.11
Turneaure
Plain Round
No. 5 and No.7
No.8
Howe No. 7 e and No. 8
(Deformed Bars)
No.1
No.2
(D.B.)
Howe Av. of 6
(D.B.)
6 Bms. Talbot 16 Bms.
No.3
Howe
No.4
2 Bms.
Talbot
3 Bms.
2 Bms.
250
200
150
100
Bond-Friction-Resistance, in Pounds per Square Inch
0
0.5
1.0
1.5
Sum of Perimeters of Rods divided by Breadth of Stem (Σ O÷B)

Fig. 6.

Berry are similar, and therefore it will be sufficient to quote the latter who found that "push-out" tests gave two and one-tenth times, and "pull-out" tests two and six-tenths times, the bond stress that had been obtained on their beam tests. He says, of these experiments:

AVERAGE COMPRESSIVE STRENGTH OF CONCRETE



Values Obtained from Tests by George A.Kimball, M.Am.Soc.C.E., on 12-In.Cubes at Watertown Arsenal, 1899; and from Tables in Taylor and Thompson's "Treatise on Concrete Plain and Reinforced." 1905.

FIG. 7.

"It is evident * * * that the maximum value of the bond between concrete and plain steel in reinforced concrete beams is between 200 and 250 lb. per sq. in., and that this value instead of the higher values usually quoted should be taken for guidance in reinforced concrete design."

It will be noted that these results are the same as the minimum value obtained from "pull-out" tests quoted from Turneaure and Maurer. This is easily explained. The specimens in the Withey tests had a value of 5 for cot. a, and those in the Berry test a value of 2; and in both cases the breadth of the concrete was two and one-half times the sum of the perimeters of the reinforcing rods. Therefore, according to Fig. 13, the Withey tests should have given more than 200 lb. per sq. in., and the Berry tests nearly 400 lb. per sq. in., if the rods in these specimens had extended into the supports.

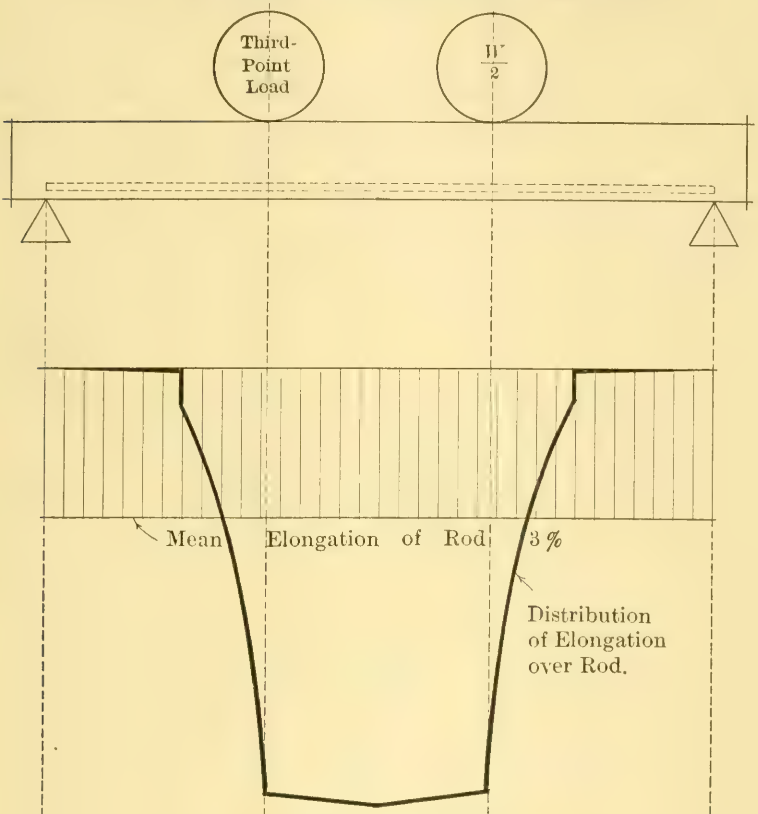
That they did not extend into the supports, and that one-half of the average bond-friction-resistance was all that was developed on the rods, is convincing proof that the writer's theory—that the bond-friction-resistance varies at different points along the rod—is true. The Berry rods extended 8 in. only, in each direction from the center of the beam, that is, one-third of the distance to the support, thus they were entirely within the field of the tensile stresses in the concrete, instead of reaching into the field of the compressive stresses at the supports.

With regard to the confusing contradictions previously mentioned as existing in the two groups illustrated in Figs. 4 and 5—that is, when the load was nearest the supports the highest values for bond-friction-resistance were obtained, yet when the load was farthest from the supports the highest values were obtained for the tensile strength of the steel—the writer has only recently arrived at a positive explanation of this anomaly. The theory underlying the explanation had been developed some time ago, having been held in abeyance until an opportunity should arise to prove it. The secret may be found from two facts:

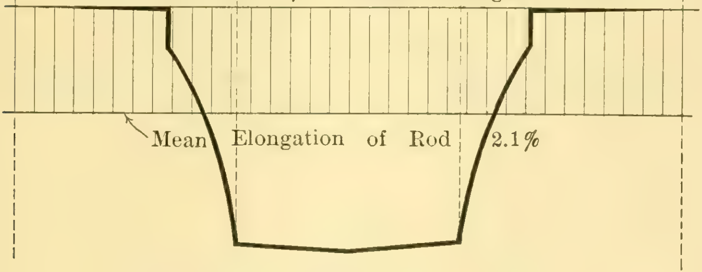
1.—The maximum tensile stress in a rod embedded in a beam that is centrally loaded is localized, rather then distributed over the entire length of the rod; thus a local increment of elongation reaching 7 or 8% will not appreciably affect the total elongation over the whole length of the rod. The exact distribution of the elongation is represented graphically in Figs. 8 and 9 for center point and one-third point load.

2.—At 90% of the ultimate strength of the steel the elongation does not exceed 6 or 7% when the rod is uniformly stressed from end

STEEL STRAINS IN REINFORCED CONCRETE.


Third-Point Load
$\frac{W}{2}$
Mean Elongation of Rod 3%
Distribution of Elongation over Rod.

Deformation at 95% Ultimate Strength of Steel.



Deformation at 85% Ultimate Strength.

FIG. 8.

to end; at 80%, from 3 to 4%, and at 70%, say, 2% elongation. (See Figs. 10, 11, and 12.)

From this evidence it will be seen that the region of plasticity of steel and iron, between the yield point and from 85 to 95% of the ultimate strength, has an important influence in reinforced concrete. The writer is of the opinion that rods thus tested will give a higher average of values than is obtained from ordinary tension tests, the reason for which is the fact that market steel is not absolutely uniform, and that the point where the maximum stress is forced to become localized is not likely to coincide with the weakest point in the material, but will more probably occur where the material has an average value.

This will be understood from a study of Figs. 10 and 11. These give the results of tests on $\frac{7}{8}$-in. rods, 6 ft. long, with a measured length of 48 in., or six standard measured units. Measurements were taken from period to period as the load progressed. The readings were taken for each inch over the entire measured length. The tests, made in the Engineering Laboratory of the University of Toronto on a 100-ton Riehlé machine, were undertaken for the express purpose of obtaining information for the construction of the two diagrams, Figs. 8 and 9. The writer was assisted in these tests by Mr. Peter Gillespie, Lecturer in Applied Mechanics in the University of Toronto, Mr. Kenneth Alexander MacKenzie, and Mr. Herman Hyman, all of whom he wishes to thank for the able manner in which the work was conducted. Special gratitude is due to Mr. Gillespie for the interest shown by him in this problem. The results of these tests are further supplemented by the diagram, Fig. 12, which gives a carefully prepared curve for the elongation of steel and iron within the region of plasticity. The abscissas represent the percentages of elongation and the ordinates the percentages of the ultimate load. This diagram is presented for the purpose of indicating the wide variation in the location of the yield point. The variations in the elongation were less variable, and seemed to fall indifferently on either side of the curve for both common iron and hard steel.

Regarding the third and fourth observations—as to the influence of the concrete between the rods in the plane of the reinforcement—it is commonly assumed that a breadth of one diameter of clear concrete between the rods is ample to develop the bond strength of the

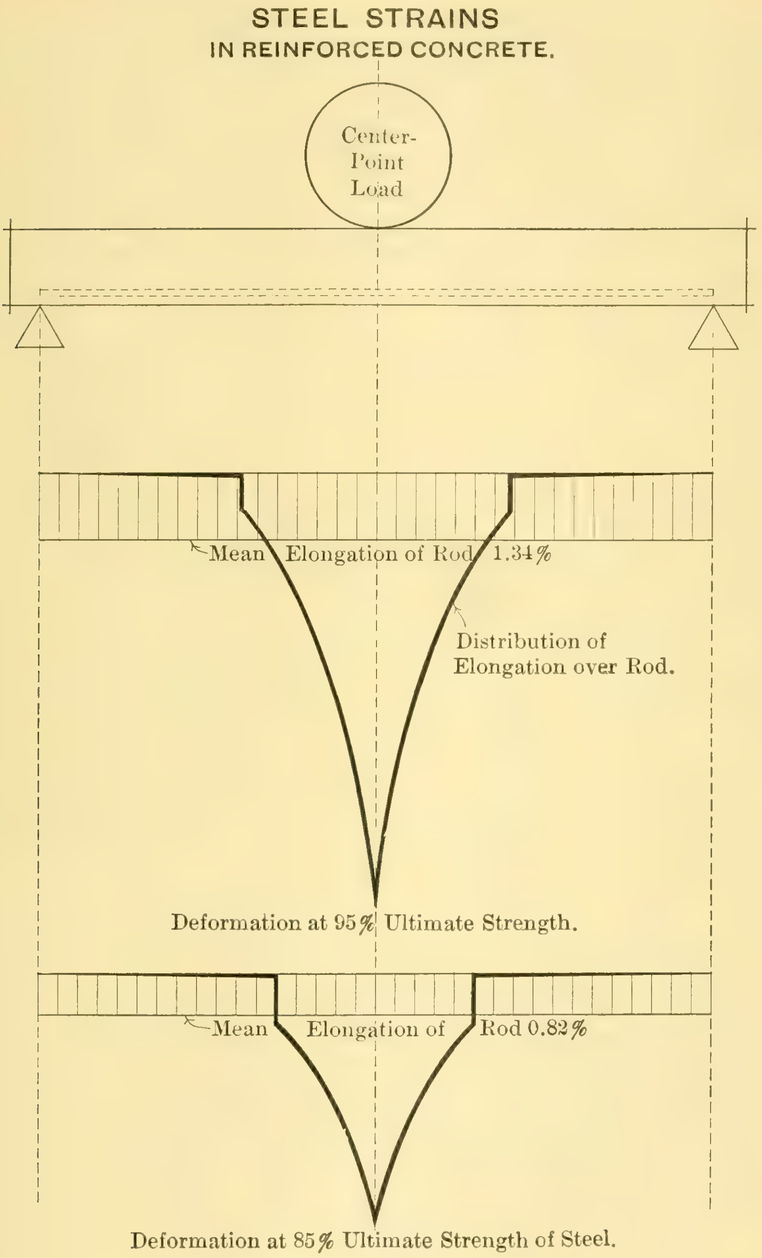

STEEL STRAINS
IN REINFORCED CONCRETE.
Center-
Point
Load
Mean Elongation of Rod 1.34%
Distribution of
Elongation over Rod.
Deformation at 95% Ultimate Strength.
Mean Elongation of Rod 0.82%
Deformation at 85% Ultimate Strength of Steel.

FIG. 9.

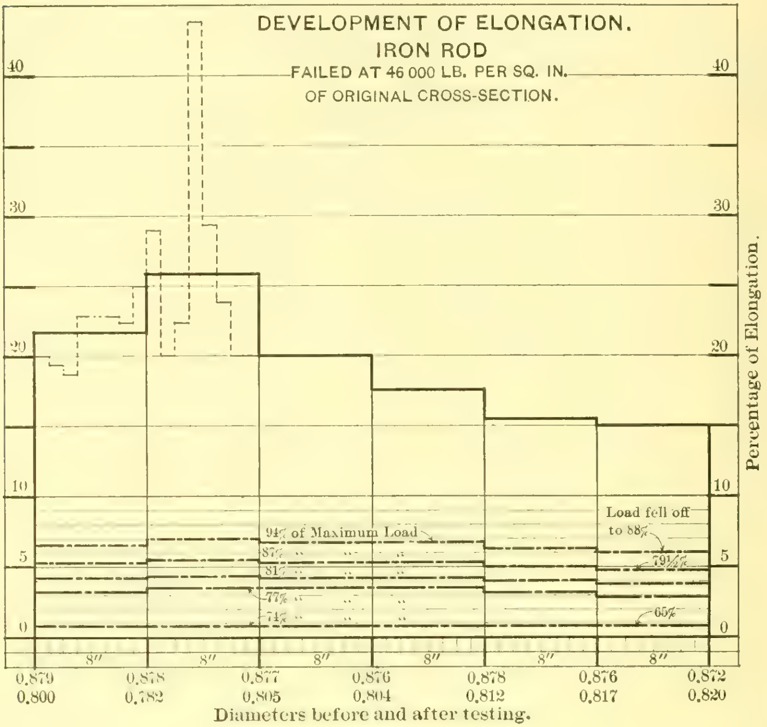

DEVELOPMENT OF ELONGATION.
IRON ROD
FAILED AT 46 000 LB. PER SQ. IN.
OF ORIGINAL CROSS-SECTION.
40
30
20
10
5
0
Percentage of Elongation.
94% of Maximum Load
87% " "
81% " "
77% " "
74% " "
Load fell off
to 88%
79½%
65%
8″
0.879
0.800
0.878
0.782
0.877
0.805
0.876
0.804
0.878
0.812
0.876
0.817
0.872
0.820
Diameters before and after testing.

FIG. 10.

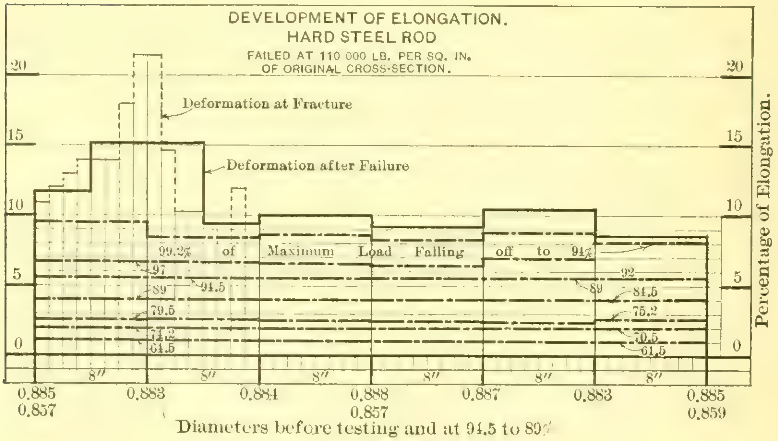

DEVELOPMENT OF ELONGATION.
HARD STEEL ROD
FAILED AT 110 000 LB. PER SQ. IN.
OF ORIGINAL CROSS-SECTION.
20
15
10
5
0
Percentage of Elongation.
Deformation at Fracture
Deformation after Failure
99.2% of Maximum Load Falling off to 94%
97
94.5
89
79.5
74.2
64.5
92
89
84.5
75.2
70.5
61.5
8″
0.885
0.857
0.883
0.884
0.888
0.857
0.887
0.883
0.885
0.859
Diameters before testing and at 94.5 to 89%

FIG. 11.

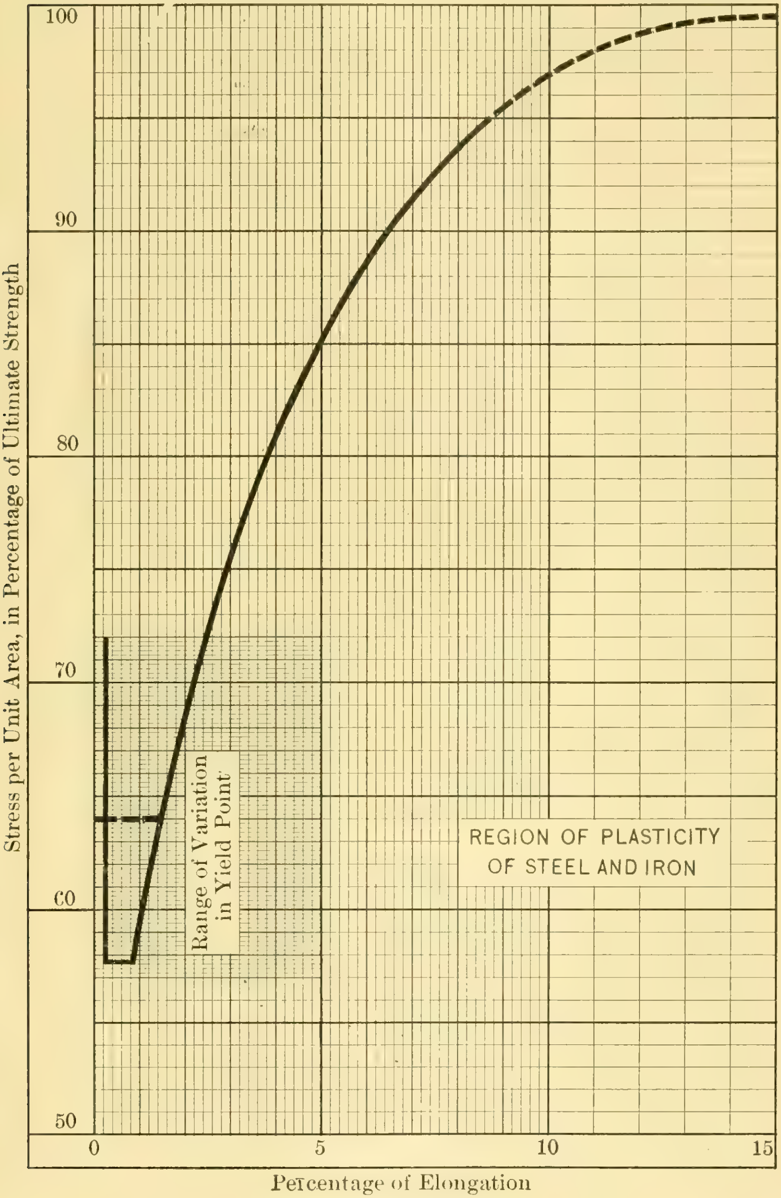

Stress per Unit Area, in Percentage of Ultimate Strength
100
90
80
70
60
50
0
5
10
15
Percentage of Elongation
Range of Variation in Yield Point
REGION OF PLASTICITY OF STEEL AND IRON

Fig. 12.

lower half surface of round rods, or of square rods when their diagonals are in the plane of the rods. The following, which is quoted from Turneaure and Maurer, fairly represents the generally accepted theory with regard to the spacing of rods or bars:

> "In rectangular or T-beams the spacing of bars is important; in T-beams this consideration will largely control the width of the beam. The requirement in general as to spacing is that the amount of concrete left between the bars must be sufficient to transmit to the upper part of the beam the stress which the bars give over to the concrete below them. If the bars are circular it may be assumed that one-half of the stress in them is given over to the concrete below, hence the strength of the concrete on a longitudinal section through the center plane of the bars must equal one-half of the stress in the bars. If the shearing stress be taken as equal only to the bond stress then the clear space between bars must be one-half the circumference of a bar, or 1.57 diameters. In the sense here employed the shearing strength is at least twice the bond strength for smooth rods, so a clear spacing of less than one diameter is sufficient from this standpoint. In the case of square bars, on the same basis, the clear spacing would need to be 1½ diameters if the bars are placed with sides vertical, or one diameter if placed with sides diagonal. But in addition to the shearing stresses there is likely to be developed more or less tension in the concrete surrounding the rods, so that there should be left ample areas of concrete between them, especially towards the end where the bond stresses are large. * * * A minimum clear spacing of at least 1½ diameters should be provided, with an equal distance between the outside rod and the surface of the beam. Where some of the rods are bent up the spacing can readily be made more liberal towards the end of the beam."

In conformity with this theory, the proposed specifications of the Special Committee on Concrete and Reinforced Concrete require that, "The lateral spacing of parallel bars should not be less than two and one-half diameters, center to center." The extra half diameter is provided for the purpose of allowing for the possibility of the placing of square bars with the sides diagonal. Owing to the great variety of forms of cross-sections of bars, it is believed by the writer that the relation between perimeter and breadth will establish a better basis for determining the correct values for bond-friction-resistance than the relation between diameter and breadth, because a bar with a major and minor axis has no fixed diameter.

According to the theory outlined by Turneaure and Maurer, the breadth of the concrete should never be less than two-thirds of the sum of the perimeters of the bars, but that is assumed to be ample.

The question was investigated carefully by the writer, and, though the data were rather meager, sufficient were gathered to prove conclusively that, say, three times the above-mentioned allowance for breadth of concrete will develop more than two and one-half times as much bond-friction-resistance.

The first hint that the writer received that the breadth of concrete between the rods was of more vital importance than was commonly supposed was obtained from a series of tests of beams by Malverd A. Howe, M. Am. Soc. C. E., of Rose Polytechnic Institute, in 1903.* The Howe series consisted of 18 beams, the reinforcement was old-style corrugated bars, and the ages were from 10 to 11 weeks. The concrete was composed of 1 of cement to 7 of aggregates. The percentage of reinforcement was practically 0.7 of 1% of the net cross-section of the concrete for all the beams. No two beams had like dimensions. Beams Nos. 1, 2, 3, and 4, were almost identical, with regard to the possible modifying influences, except that of the ratio of the perimeter of the rods to the breadth of the concrete in the plane of the reinforcement. A very decided rate of increase was noted in the resulting bond-friction-resistance developed on these four beams due to the increase in breadth of concrete between rods. Besides this series just mentioned, several other groups were found for both plain rods and deformed bars. These groups have been plotted on Fig. 6, the ordinates giving the bond-friction-resistance in pounds per square inch of the surface of the bar, and the abscissas giving the ratio of the perimeter of the rods to the breadth of the beam. In each individual group of beams every beam had a common value for cot. a, thus making the normal component of bond stress constant for that group.

The following method was devised for establishing a relation between the values on this diagram and the values previously determined in Fig. 4: In the beams represented in Fig. 4 the sum of the perimeters of the rods was equal to $\frac{78}{100}$ of the breadth of the concrete, therefore this value for the spacing of the rods was adopted as the unit value for comparison of the results in Fig. 6. A point was chosen on the ordinate passing through the abscissa ($\frac{78}{100}$), but near the top of the diagram. This point then became the nucleus of a new set of diagrammatic values with the abscissas as before and the ordinates to be established in the following manner:

---

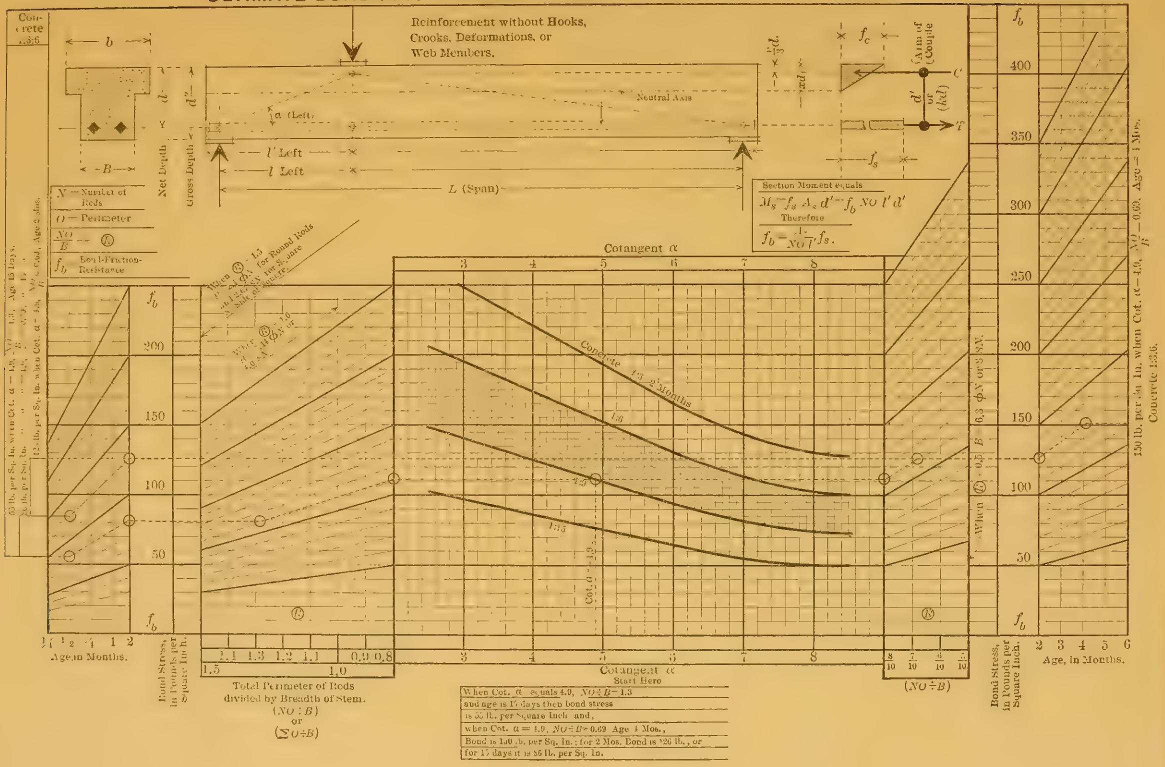
* A Report of these tests may be found in the *Proceedings*, Am. Soc. for Testing Materials, in Mr. Condron's discussion of Professor Talbot's tests, Series of 1904.

Through this nucleus, lines parallel to those in the lower figure were drawn. Where an average direction for two or more groups was desired, the protractor was used to obtain the mean inclination of the series with respect to the horizontal axis. Thus a line representing the entire series of plain bars was constructed; similarly, curves for the entire series of deformed bars, and for all the bars, deformed and plain, were obtained. These are the values to be found on the upper diagram in Fig. 6. It will be noticed that there is practically no difference in the results obtained for plain or for deformed bars—both seem to be equally influenced by the increase or decrease of the concrete between the bars.

The specimens in the preceding investigation were practically two months old, therefore the values are only true for that age. The writer found no sufficiently elaborate reports of tests on beams to enable him to establish a basis for judging of the influence of age of concrete on bond-friction-resistance. Therefore, a careful study was made of the investigations of Kimball, as conducted at the Watertown Arsenal, and of the theories of Taylor and Thompson, as given in "Concrete, Plain and Reinforced," on the effect of age on the compressive strength of concrete. The results of this study are given on Fig. 7. It is fair to assume that the influence of age on concrete is relatively the same, whether it be stressed in compression, in tension, or in bond. This assumption was made for the values as plotted on Plate CLXIX, and odd experiments on age influence seem to bear out the probable truth of the assumption.

Further explanation as to the method of construction of the additional curves on Fig. 4 is necessary here. It will be recalled that the curve for the 1:9 mixture was plotted from a very large number of experiments, the individual values being shown adjacent to the curve. Talbot's experiments, Series 1907-08, provided the information which enabled the writer to construct the curves for the 1:15, the 1:6, and the 1:3 mixtures, as shown. These experiments show that for a given value of cot. a (2.8 in this specific instance), the values of the bond-friction-resistance—other things being equal—were as follows:

ULTIMATE BOND-FRICTION-RESISTANCE ON PLAIN RODS AND BARS.



When Cot. α equals 4.9, NO ÷ B = 1.3
and age is 15 days then bond stress
is 63 lb. per Square Inch and,
when Cot. α = 4.9, NO ÷ B = 0.69 Age 4 Mos.,
Bond is 150 lb. per Sq. In.; for 2 Mos. Bond is 126 lb., or
for 15 days it is 56 lb. per Sq. In.

For a 1:9 mixture	100 (assumed)
“ “ 1:6 “	138
“ “ 1:3 “	176
“ “ 1:15 “	68

It was then assumed that for other values of cot. a, the same relations would obtain. Hence the 1:6 curve was drawn so that each of its ordinates is 38% greater than the ordinate on the 1:9 curve; for like values of cot. a, similarly, all values of the ordinates to the 1:15 curve are 68% of the values of the ordinates to the 1:9 curve. A glance at Fig. 7 indicates the relative compressive strength of various grades of concrete at one month to be:

For a 1:9 mixture	100 (assumed)
“ “ 1:6 “	120
“ “ 1:3 “	140
“ “ 1:15 “	60

The writer believes that the bond-friction-resistance is affected to some extent by richness of mixture, in a manner similar to that in which compressive strength is modified by the same influence. He has the additional conviction that the curves shown on Fig. 4 are probably somewhat high, and that values of the ordinates somewhere in the neighborhood of the mean of those just quoted for compressive strength, and those from which the curves were plotted, would more nearly represent the facts. He recognizes also that variation in material, manipulation, and method are quite unavoidable, under all circumstances; that in any kind of experimental investigation a close degree of refinement is absolutely impossible, and that the unbiased investigator must never lose sight of the personal equation in individual experiments.

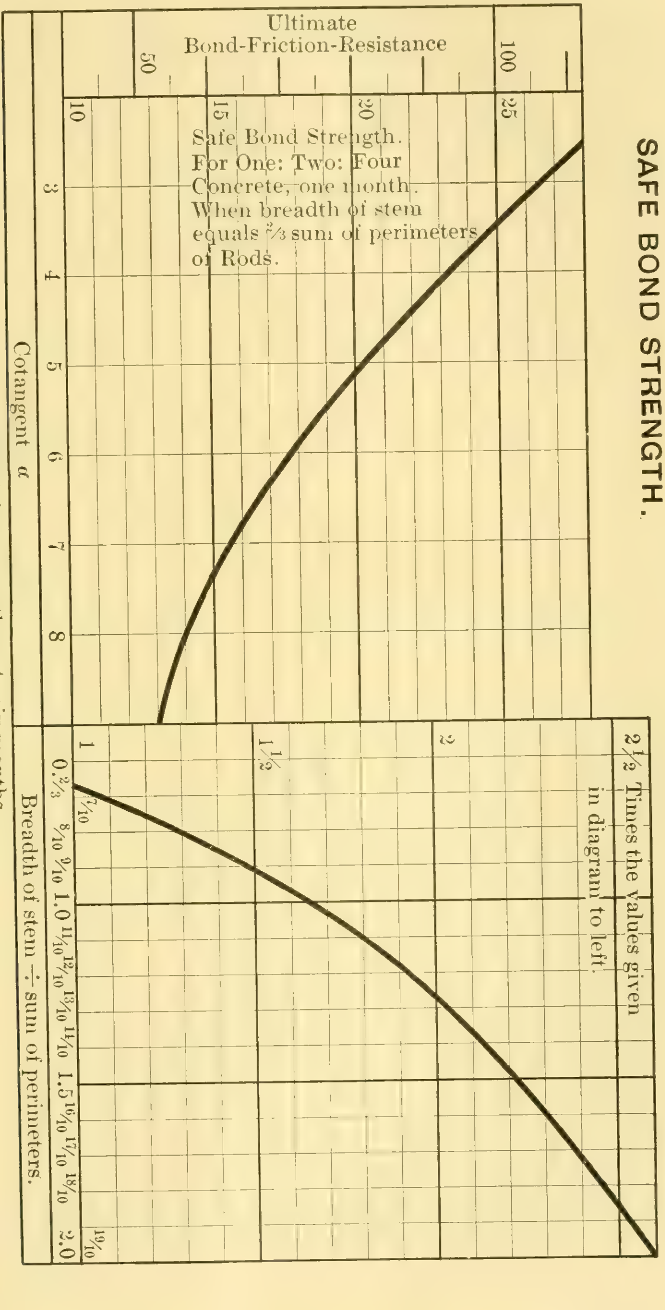
Plate CLXIX is a composite diagram, constructed from the results in Figs. 4, 6, and 7. Therefore it gives a comprehensive picture of the whole investigation, and will serve for laboratory and investigation purposes as a means for checking the accuracy of these new laws. It is rather too complicated for daily office use in reinforced concrete design, for which purpose Fig. 13 has been prepared. The latter is a double diagram, for concrete 1 month old and mixed in the proportion of 1 of cement to 2 of sand and 4 of coarse aggregates. The abscissas in the left-hand diagram give values for cot. a, and the ordinates the bond-friction-resistance. The abscissas in the right-hand diagram give values for the breadth of concrete divided by the sum of the perimeters of the rods, and the ordinates are multiples of the ordinates which must first be obtained from the left-hand diagram. It will be noted that the values in this diagram are made for the standard concrete for use in reinforced concrete as laid down by the Special Committee on Concrete and Reinforced Concrete.

What has gone before refers to reinforcement with plain bars, embedded in the bottom of the concrete beam, with their axes parallel to its top. This was adopted as a type, for comparison with alternative or modified methods as alleged improvements. Improvement as here considered is any change made in this type. For instance, the following are some of the changes which have been considered in this class:

a. Deformations on rods,
b. Hooks on the ends of rods,
c. Bending rods upward to near the top of beam,
d. Stirrups for the web of the beam,
e. Combinations of two or more of the preceding.

Special care was taken to investigate thoroughly the standard type of reinforcement, so as to establish values with which to compare other alleged improvements. As a matter of fact, there were more data for the standard than for the others; however, sufficient were gathered to warrant the following statements:

a.—Deformations as media for increasing bond strength are of doubtful value. Any increase in strength resulting from the use of deformed bars is found to show itself only after the yield point of the bond has been passed. It will be noted in the studies for steel elongation in reinforced concrete beams that deformed bars sometimes exhibit a slower development in the slipping than is indicated by plain bars. A good illustration of this will be found by comparing Lanza beam *A*-2 with the Lanza beams *A*-1 and *C*-5, in Fig. 2. It will also be noted that deformed bars sometimes begin to creep earlier than plain bars. This is indicated by comparing the Talbot beams Nos. 27 and 28 in Fig. 1, and it will be found that this is by no means an uncommon occurrence; it may be due to a difficulty in getting the concrete to reach into the corners of the deformations.



SAFE BOND STRENGTH.

Safe Bond Strength.
For One: Two: Four
Concrete, one month.
When breadth of stem
equals ⅔ sum of perimeters
of Rods.

Add 10% per month up to six months

Fig. 13.

The writer is of the opinion that, with proper tamping of concrete, the deformed bars of the twisted and corrugated type would probably give about 15 or 20% increase over plain bars.

The re-rolling necessitated in the manufacture of deformed bars usually has the effect of raising the elastic limit of the steel, and it is to the increase thus produced that a great deal of the merit of deformed over plain-bar reinforcement may be attributed. In the majority of cases it will be found that the bond-friction-resistance developed on deformed bars seldom exceeds, in fact seldom seems even to reach, that developed on plain bars under similar conditions. Now and again a group of beams will be found to indicate 30 or 40% increase due to the deformed bars. This seems to be particularly the case when the beams have been cured in water. This would cause a tightening of the grip of the concrete on the deformations of the rods resulting from expansion. Such results, however, have not been general, and, further, they have not been found to vary greatly from those given for the standard reinforcement on Plate CLXIX; or, in other words, it has usually been the case that the plain bars with which they were compared behaved very badly. In every case average values for any of those groups varied less from the diagrammatic values than the variations in like beams in any group. This was true when the groups were from different laboratories, in which case the averages would also vary according to the practices of each laboratory. Thus the variations in the values in such groups may be considered as due mainly to the erratic nature of the concrete rather than to the influence of the deformations on the bars. Witness the series of groups in Table N-1, Bulletin No. 148, of the University of Wisconsin, by Ernest A. Moritz, Assoc. M. Am. Soc. C. E. In no case are there developed as high values for bond-friction-resistance for deformed bars as for plain bars.

This series may be assumed to be a representative one because of the fact that there are never less than four beams (usually five) for each kind of reinforcement, and nearly the same for each age, 1, 3, and 6 months, as shown on Table 1. In every case there is a much greater variation between the average values and the maximum and minimum values for each group than between the average values of the several groups and the values to be obtained from Plate CLXIX. The minimum variation from the averages for each group was in one case 54% and the maximum variation 147 per cent. The minimum

TABLE 1.—DEFORMED VERSUS PLAIN BARS. MORITZ TESTS ON REINFORCED CONCRETE BEAMS. ALL BEAMS OF 1 : 3 MORTAR. EACH BEAM CONTAINS ONE STEEL ROD.

Age, in months.	PLAIN BARS.		DEFORMED BARS.	
	½-in. round.	⅜-in. round.	Twisted, ½-in. square.	Corrugated, ½-in.
	A_s = 0.197 sq. in. $\frac{B}{\Sigma O} = 1.93$ Cot. a = 4.5	A_s = 0.110 sq. in. $\frac{B}{\Sigma O} = 2.55$ Cot. a = 4.35	A_s = 0.25 sq. in. $\frac{B}{\Sigma O} = 1.5$ Cot. a = 4.55	A_s = 0.18 sq. in. $\frac{B}{\Sigma O} = 1.77$ Cot. a = 4.5
	LOADS AT FAILURE.			
One.	4 000 5 250 4 100 4 500 4 400 4 500 Av. = 4 460 f_b = 292	2 600 3 000 2 700 2 000 Av. = 2 575 f_b = 215		
Three.	2 800 4 200 6 000 5 600 6 500 Av. = 5 020 f_b = 328		5 500 5 000 4 600 4 600 5 800 Av. = 5 100 f_b = 263	4 400 4 600 4 650 5 500 5 500 Av. = 4 930 f_b = 296
Six.	5 300 4 900 5 600 4 600 Av. = 5 100 f_b = 333		6 000 2 200 2 640 5 660 Av. = 4 075 f_b = 211	6 200 5 000 6 000 5 400 4 200 Av. = 5 360 f_b = 322

variation of the averages for each group is in one case 62% of the values in the diagram, and, strange to say, that was for a group of deformed bars. Considering only the plain-bar reinforcement in this series, the minimum variation of these experimental values from those on the diagram is 81% and the maximum 130% of the diagrammatic values. Also, in the Lanza and Talbot beams, there cannot be said to be any appreciable increase in the ultimate bond-friction-resistance due to the deformations on bars. In the case of Talbot beam No. 9, which was reinforced with three twisted bars, ½ in. square, the ultimate bond-friction-resistance was 168 lb. per sq. in., while in Nos. 16 and 17, which were each reinforced with three plain bars, ½ in. square, the ultimate bond-friction-resistance was 81 and 82 lb. per sq. in. In both cases $B = 2 \Sigma O$ and cot. $a = 5.2$. Now, according to Plate CLXIX, the average value for bond-friction-resistance for plain-bar reinforcement, as in Nos. 16 and 17, is 145 lb. per sq. in. Thus it is evident that these two beams must have been of very poor concrete; on the other hand, beam No. 9, with deformed-bar reinforcement, developed only 16% more than the average value obtained where plain bars were used. Beam No. 13 developed 104 lb. per sq. in., or 16% more than the average; No. 28 developed 105 lb. per sq. in., or 40% more than the average; while Nos. 3 and 7 developed only 67% of the average value for the bond-friction-resistance given on the diagram. The foregoing are the deformed bars. The plain bars behaved in a similar manner. Beam No. 21 developed 60%; No. 19, 60%; and No. 27, 110% of the average values on Plate CLXIX. In other words, it is apparent that variations in bond-friction-resistance are attributable to such influences as age, the position of the load, the ratio of steel perimeter to width of stem, etc., rather than to special deformations in the reinforcement, except as indicated above. Yet, if the writer's suspicions regarding the values for the 1:6 concrete in Plate CLXIX and Fig. 13 are correct, that is, that the ordinates may be, say, 7% too high, the foregoing deductions or comparisons are subject to a slight modification in favor of the deformed-bar reinforcement.

b.—Hooks on the ends of rods do not produce any increase in the strength of the reinforcement. They even tend to cause failure to occur sooner than when they are omitted.

With regard to the combination of hooks, bends, and stirrups in the reinforcement of a concrete beam, a rather curious anomaly is apparent in the results of any experiments on such a combination of which the writer has been able to obtain reports. In no case does such a combination show a materially higher development of bond-friction-resistance than the plain straight-rod reinforcement without hooks, bends, or stirrups, yet the effect of bending some rods without the use of stirrups or hooks, materially increases the bond-friction-resistance, and, also, when stirrups alone are added to the plain straight-rod reinforcement, a marked increase occurs. The separate influence of these will now be considered.

c.—Beams with reinforcing bars bent up have been investigated by Talbot. The following is from the results of his investigation.*

---

*Bulletin No. 29, University of Illinois Experiment Station.

"As may be expected, in the beams with all the bars bent up, as soon as the concrete at the bottom was sufficiently stretched, a vertical tension crack formed at some point between the beam support and the bend of the bar, extending from the bottom of the beam to the level of the reinforcing bars. * * * After the formation of this vertical crack, the tension in this part of the beam is taken mainly by the reinforcing bar; and as its depth below the top of the beam * * * is considerably less than in beams having the bars horizontal throughout, the tensile stress developed in the bar at this section is greater than in beams having the reinforcement horizontal throughout. * * * As the tensile stress in the steel at this section is greater than when the bars are horizontal, the amount of bond brought into action toward the end of the bar must be greatly increased. There is evidently, then, a greater chance for slip of bar in such beams than in beams where straight reinforcement is used."

Comparing the results of beams with all the bars bent up and the results of beams with all straight bars, there was no material difference in the bond-friction-resistance when the stresses on the cross-section under the load were considered for both cases. The writer believes that, on one hand, there is a gain due to the rods reaching into and being acted on by the compressive stresses in the beam, and, on the other hand, a loss due to the reduction of the length of the arm of the couple—the loss and gain are apparently about equal. Beams with part of the rods bent up and part left straight develop from 25 to 50% higher values than beams with the rods all straight. It is reasonable that this should be so. The concrete between the rods is increased from the beginning of the bend to the end of the beam, and such an increase has already been found to be a material factor in increasing the bond-friction-resistance. (See Fig. 6.)

Much depends on the manner of bending, but the most important point is to guard against sharp bends in the rods.

d.—Stirrups.—A series of tests on beams by the Boston Transit Commission,* is interesting because it shows that, as the proportion of concrete between the rods decreases, the value of the stirrups increases. Thus, of beams with $\frac{81}{100}$ of 1% reinforcement, those with stirrups were 25% better than those without stirrups; when 50% more reinforcement was put in similar beams, there was 50% increase in the value of the stirrups, that is, those with stirrups were 37% better than those without stirrups; and, when double the reinforcement was put in the beams, there was a twofold increase in the value of the stirrups, that is, those with stirrups were 56% better than those without stirrups.

---

* Reported by Turneaure and Maurer.

In the Talbot series of 1907-08 the use of stirrups has been studied. The beams were 1:2:4 concrete, two months old, with cot. $\alpha = 2.8$. In plain-rod reinforcement, with $B = 1.28 \Sigma O$, the average value for the beams with stirrups was 20% better than for those without stirrups. When $B = 1.03 \Sigma O$, beams with stirrups were 18% better than those without. Beams with this value of B and having deformed-bar reinforcement were 26% better with than without stirrups. This illustrates in an entirely new manner the effect of the suspension of the concrete below the plane of the steel by the concrete between the rods. In this way, the stirrups are seen to perform the function which would otherwise be performed by a proportionate quantity of concrete.

e.—Combinations of Two or More of the Preceding.—One case, only, will be considered: the combination of stirrups with part of the rods bent up and part left straight. As previously mentioned, there does not seem to be any evidence of improvement over plain straight rods without stirrups. The only way the writer can account for the absence of improvement is in the possibility that the stirrups disturb the concrete around the region of the bent rod, thus destroying some of the advantage due to the influence of the compressive stresses on that bent rod. It is also probable that the absence of improvement is partly attributable to the fact that the reinforcement usually consisted of rods bent at sharp turns, instead of having continuous easy curves throughout.* Further investigation may throw new light on the question.

As to the practical aspect of the results of this investigation, with particular reference to the question of reinforced concrete design, a few points should be mentioned.

The problem of reinforced concrete design must be decided on purely scientific lines. In the writer's opinion, tests in reinforced concrete buildings are utterly impracticable and useless. Such tests are deceptive and misleading, because of many influences, more or less transitory, which aid the tested panel or series of tested panels so materially that, though incalculable and uncertain, they are nevertheless the dominating factors in carrying the loads. The loads themselves are seldom what they seem. It is necessary to understand the value of each element in a design, from a special study of that element. Its relation to the general problem must always be based on the judgment of the designer.

---

* See "Some Mooted Questions in Reinforced Concrete Design," by Edward Godfrey, M. Am. Soc. C. E., *Proceedings*, Am. Soc. C. E., for February, 1910.

With regard to the question of loads in building work, it is the custom to specify a uniform distribution of loading. Buildings have been classed on the basis of the use to which they are to be put. The method of fixing the standard of classification has been by the determination of the uniform live load each class will safely carry. The precedents existing to-day as to what each class should be designed to sustain are based on a history of accidents. The lessons learned from these accidents have been so dearly bought that a designer must be bold indeed to presume to set up his judgment against the standard specified loadings for various classes of buildings. As previously mentioned, these standards are given in terms of the relative values for a uniform distribution of loading. Now, it can be shown that the comparative effect of a uniformly distributed load and a center concentrated load on a reinforced concrete beam is not the same as their comparative effect on a steel, a timber, or a plain concrete beam. It is commonly known that in the latter cases the effect of a concentrated load is double that of a uniform load on like beams; but in the case of a reinforced concrete beam, of the standard type, previously referred to, the bond-friction-resistance under a uniform load is not the same as under a concentrated load in the center of the beam. It is not unreasonable that this should be the case. For instance, consider the stresses produced on the cross-section midway between the center of the beam and the center of its supports. For uniform load, the strain on the cross-section is 75% of the strain at the center; and for center concentration of load, the strain is only 50% of the strain at the center (this is illustrated for any cross-section between the center and the support by Fig. 14), that is, uniform load will develop 50% more strain on the bond at the quarter-point than will be developed by center load. This is based on the assumption that the steel in each beam is strained alike at the center cross-section. Owing to the variable nature of the bond-friction-resistance, it would be an endless task to determine theoretically the location of the cross-section where failure would occur on a reinforced concrete beam under a uniform distribution of load. However, experiments seem to indicate that failure will occur coincidently when like beams are loaded uniformly or are loaded at the center with 70% of the uniform load. This value, therefore, may be used as a basis for uniform loads when the values for the bond-friction-resistance given in Fig. 13 are under consideration.

The formulas for such a case would be developed as follows, when W = the total uniform load on the beam or girder:

$$M_b = \frac{70}{100} \frac{W\,l}{4} = 0.175\, W\,l$$

$$M_s = f_s\, A_s\, d' = f_b\, \Sigma\, O\, l'\, d'$$

$$\text{or } W\,l = 5.7\, f_b\, \Sigma\, O\, l'\, d'.$$

In this case l' will be half the length of the rod.

The size of the rod is an important factor in such reinforced concrete as depends on bond-friction-resistance to develop the tensile strength of the steel. This is plainly evident from the fact that, for equal areas of cross-section, the perimeter of rods or bars increases inversely as the diameter or side. This is true for round or for square sections. For instance, the perimeter of a 1-in. square bar is 4 in., the perimeter of a ¼-in. square bar is 1 in., and it requires sixteen bars per square inch of area, thus sixteen ¼-in. bars expose four times as much area of surface as a 1-in. bar. This is illustrated, for beams which have the real working dimensions most commonly used in buildings, in Figs. 15 and 16. In Fig. 15, it will be seen that, for the standard type of reinforcement, ¼-in. rods develop 64 000 lb. per sq. in. on an 18-ft. span uniformly loaded, when $B = \frac{2}{3} \Sigma\, O$; ½-in. rods, 32 000 lb., and 1-in. rods only 16 000 lb. per sq. in. When $B = 2\, \Sigma\, O$ (Fig. 16), ⅝-in. rods develop 67 000 lb.; 1-in., 42 000 lb., and 2-in. rods only 21 000 lb. per sq. in., on an 18-ft. span uniformly loaded.

With regard to the determination of the neutral axis and the centroid of compressive stress, the ordinary methods, as laid down by the Special Committee on Concrete and Reinforced Concrete, may be used for the working stresses on reinforced concrete. On the other hand, from the yield point of the bond, which occurs at about three-

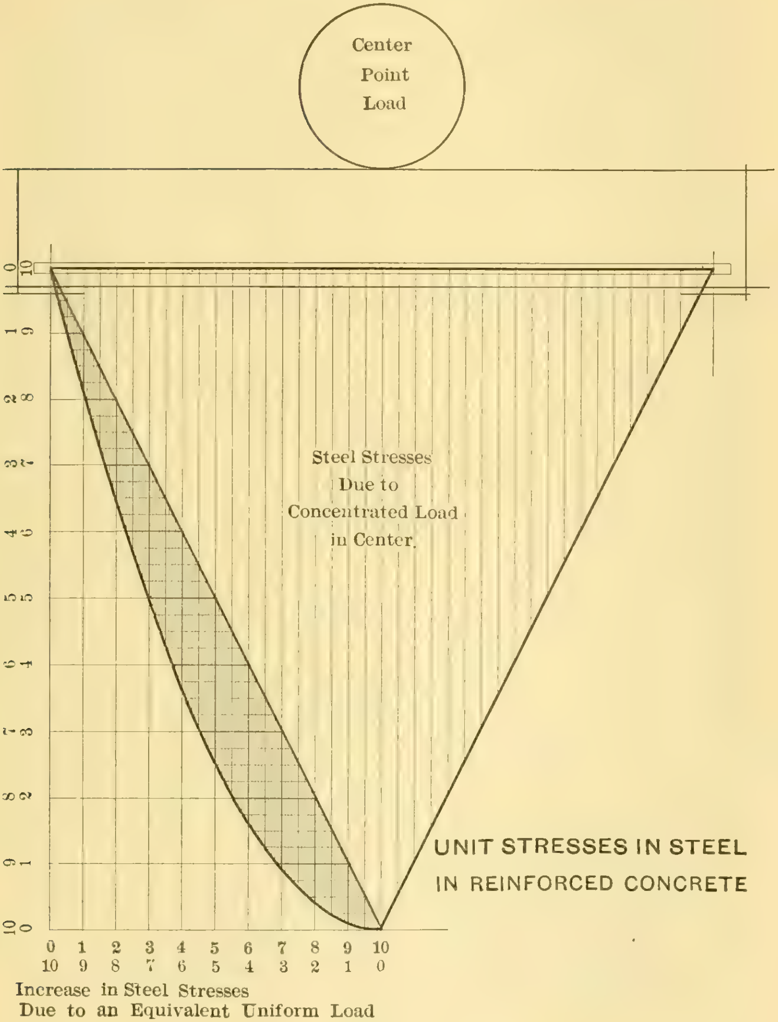

Center
Point
Load
Steel Stresses
Due to
Concentrated Load
in Center.
UNIT STRESSES IN STEEL
IN REINFORCED CONCRETE
0 1 2 3 4 5 6 7 8 9 10
10 9 8 7 6 5 4 3 2 1 0
Increase in Steel Stresses
Due to an Equivalent Uniform Load

FIG. 14.

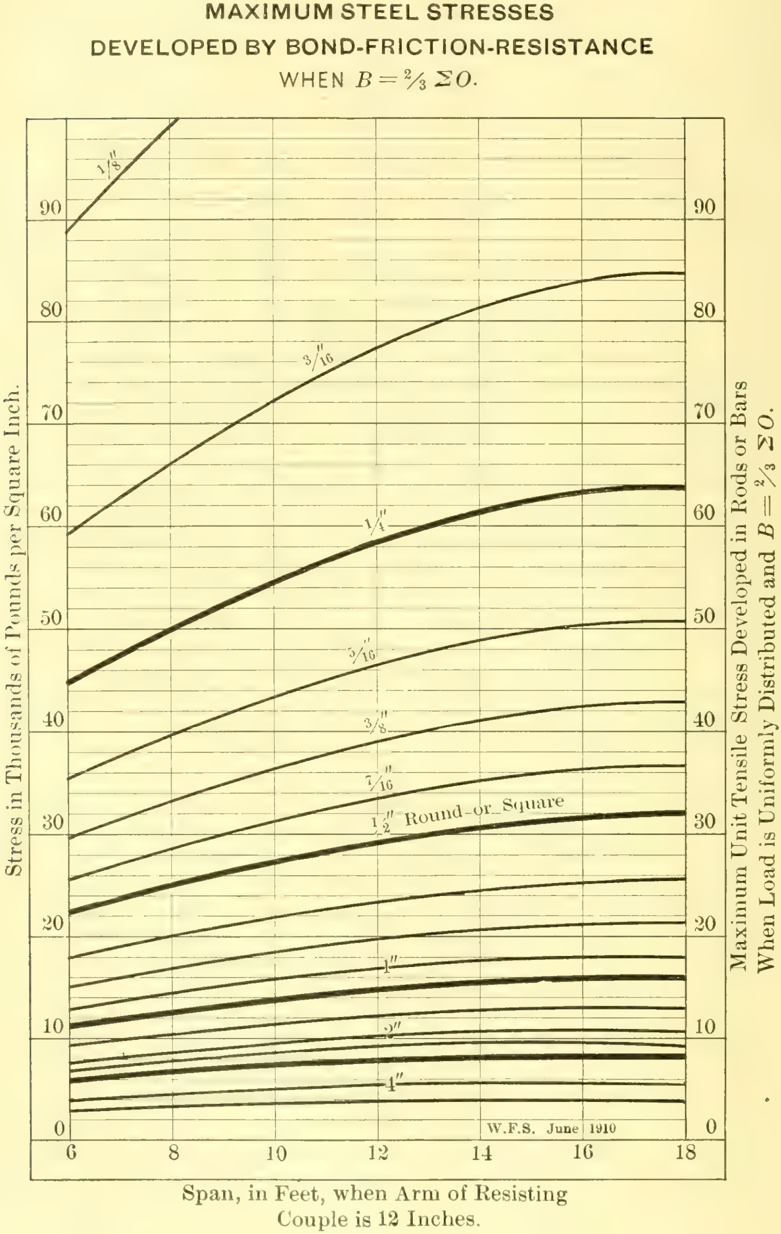

MAXIMUM STEEL STRESSES
DEVELOPED BY BOND-FRICTION-RESISTANCE
WHEN $B = \frac{2}{3} \Sigma O$.

FIG. 15.

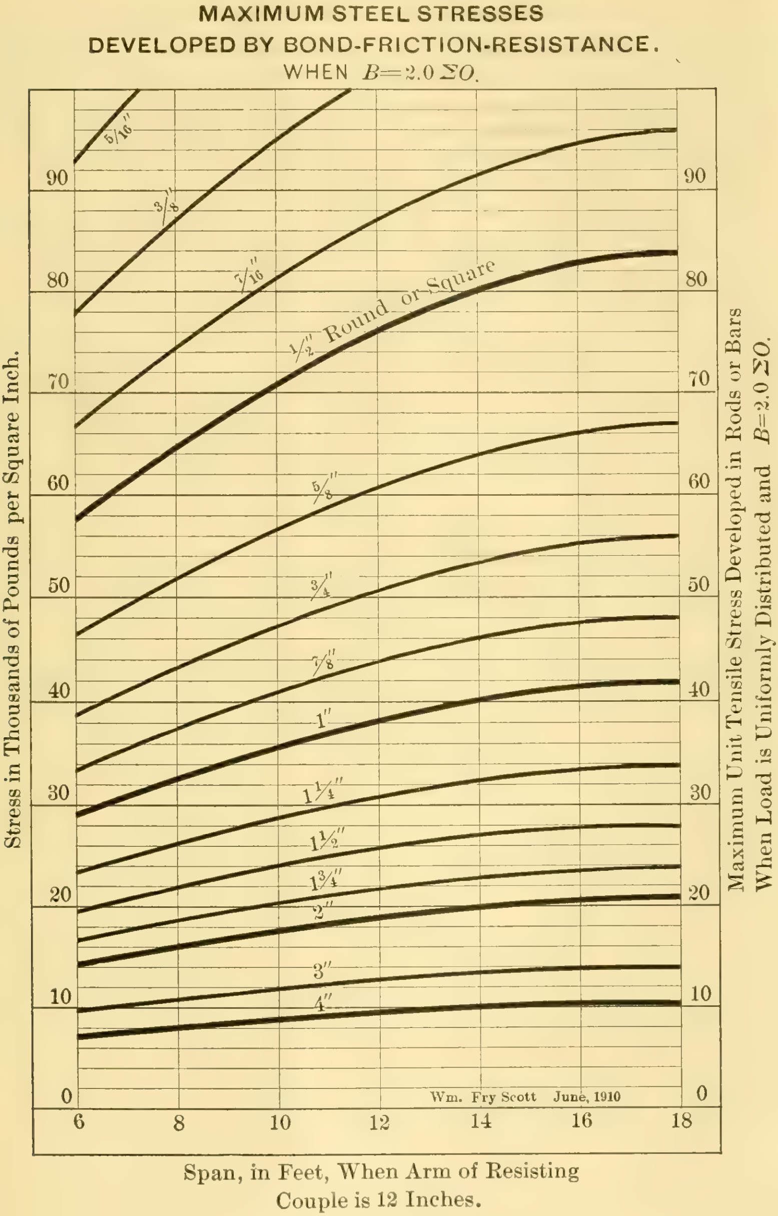

MAXIMUM STEEL STRESSES
DEVELOPED BY BOND-FRICTION-RESISTANCE.
WHEN $B=2.0\,\Sigma O$.
Stress in Thousands of Pounds per Square Inch.
Maximum Unit Tensile Stress Developed in Rods or Bars
When Load is Uniformly Distributed and $B=2.0\,\Sigma O$.
0
10
20
30
40
50
60
70
80
90
6
8
10
12
14
16
18
5/16″
3/8″
7/16″
1/2″ Round or Square
5/8″
3/4″
7/8″
1″
1 1/4″
1 1/2″
1 3/4″
2″
3″
4″
Wm. Fry Scott June, 1910
Span, in Feet, When Arm of Resisting
Couple is 12 Inches.

FIG. 16.

eighths of the ultimate bond-friction-resistance, to the point of failure of the beam, the slipping of the rods has the effect of gradually raising the centroid of the compressive stresses, or, in other words, of increasing the length of the arm of the couple formed by the tensile and compressive forces. This increase at very near failure probably seldom exceeds 5 or 6% of the computed length of the arm.

In conclusion, the writer desires to say that at first glance the evidence presented herewith points to the fact that the stresses, in such reinforced concrete as depends on bond-friction-resistance to develop the tensile strength of the reinforcement, are much more complicated than has hitherto been supposed. This is true from a purely technical point of view only, and, notwithstanding the very valuable investigations of Messrs. Hatt, Talbot, Turneaure, Howe, Humphrey, Lanza, Marburg, Harding, and others, without whose work it would have been impossible to prepare this paper, and to whom the writer before closing wishes to express his indebtedness, there is a tremendous amount of work still to be done in engineering laboratories in the way of further investigation before the last word has been said on this subject. The Profession is especially indebted to those eminent investigators who have unselfishly reported full and comprehensive data on their experiments, thereby enabling any practicing engineer to draw his own conclusions from the material presented.

Vol. XXXVI. OCTOBER, 1910. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

TWO REINFORCED CONCRETE COAL POCKETS.*

By Myron S. Falk, M. Am. Soc. C. E.

The type of coal-pocket construction used in New York City by retail coal dealers has, until lately, consisted of a timber structure supported on brick walls, or on wooden posts.

These pockets have wooden bottoms and sides, and are arranged so that coal teams and carts can be driven below and filled promptly by opening a chute in the bottom of the bin.

On account of the fire risks connected with such structures, and perhaps even more on account of the rapid deterioration of the timber and the difficulty of making repairs, a number of reinforced concrete pockets have lately been constructed. This paper describes two pockets of this kind built during the past year.

Pocket No. 1 is constructed entirely of reinforced concrete. It is on Chauncey Street, near Evergreen Avenue, Brooklyn, on a siding of the Long Island Railroad, and was built for the Peoples' Hygienic Ice Manufacturing Company, by the Haiss Manufacturing Company, of New York, from plans prepared by Mr. Ernest Abs-Hagen, the engineer of the company. Albert B. Hager, Assoc. M. Am. Soc. C. E., and the writer acted as consulting engineers for the owners.

In Pocket No. 2, only the posts and bottom of the bin are of concrete; the sides and roof are of timber. It is on the east side of the

---

* This paper will not be presented at any meeting, but written communications on the subject are invited for publication with it in *Transactions*.

Harlem River, near 177th Street, New York City, and was built for Olin J. Stephens, Incorporated, by the Godwin Construction Company, from plans prepared by Messrs. Monks and Johnson, Engineers.

Pocket No. 1 has a capacity of 4 000 tons. Its dimensions are 100 by 55 ft., over all, and its height from the ground to the high point on the roof is 60 ft. 6 in. It is carried on twenty-eight reinforced concrete posts, each 30 in. square, spaced 12 ft. 5 in. apart in the clear, and differs greatly in its manner of support from Pocket No. 2, in which the columns are spaced in longitudinal rows. The pocket overhangs the outside row of columns by 4 ft. 6 in., the floor-beams are cantilevered beyond the columns, and the weight of the reinforced concrete side-walls does not rest directly on a beam over the columns, but is supported on the cantilevered floor-slab. A similar form of construction was adopted for Pocket No. 2.

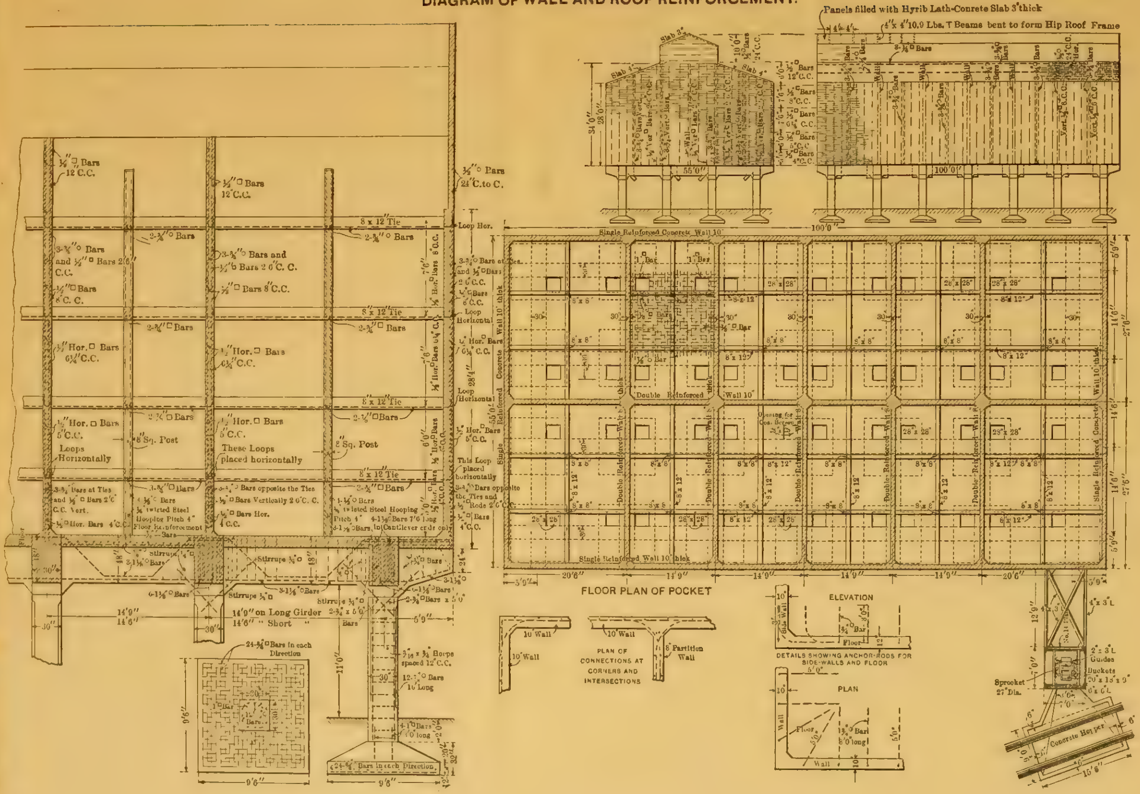
Pocket No. 1 is divided into twelve compartments by interior reinforced concrete partitions, uniformly 8 in. thick, which are tied to each other and to the outside walls by reinforced concrete ties, 8 by 12 in. in section. These ties are supported at their third points by 8 by 8-in. posts. The outside walls, heavily reinforced, as shown on Plate CLXX, are 10 in. thick.

The weight of the coal is carried on a concrete slab 16 in. thick, reinforced in two directions by $\frac{7}{8}$-in. corrugated bars 6 in. from center to center. The slab, in turn, is supported by the floor-beams, which are 48 in. deep and 30 in. wide. These are reinforced by $1\frac{1}{8}$-in. bars, six at the bottom and four at the top, bent as shown on Plate CLXX, which also shows the stirrups and the general reinforcement in the cantilever beams and the walls. The 30-in. columns are reinforced with twelve $\frac{7}{8}$-in. and four 1-in. rods, hooped and tied as shown. The reinforced footings of the columns rest on hardpan, and are 9 ft. 6 in. square.

Coal is delivered by bottom-dump cars into a concrete hopper on the siding, from which it is transferred by a bucket conveyor to the center loft of the pocket. It is carried from that point by a single-strand flight conveyor running the length of the pocket to the various compartments, trip-ups being provided so that any desired bin may be filled. Each bin has four bottom chutes, each 24 in. square, through which the coal is delivered into the wagons. Screens are placed in the chutes in order to give the coal a final screening before delivery.

PLATE CLXX.
PAPERS, AM. SOC. C. E.
OCTOBER, 1910.
FALK ON
REINFORCED CONCRETE COAL POCKETS.

DIAGRAM OF WALL AND ROOF REINFORCEMENT.



The walls of the pocket were designed so that any compartment might be filled while neighboring compartments were empty.

The difficulties of constructing this pocket were many, because the reinforcing rods in the outside walls acted as an impenetrable fence and prevented the placing of concrete within the bin; consequently, all concrete had to be carried to the full height of the outside walls, and then lowered inside the pocket. The method adopted by the contractors appeared to overcome this difficulty very satisfactorily. A traveling concrete mixer, with a bucket conveyor extending the full height of the outside walls, was erected on the outside of each of the longer sides of the pocket, and, from the top of the conveyor, wooden troughs conducted the concrete directly to its proper place. The scheme appeared to be feasible and not expensive, because, the contractor's main business being the building of coal machinery and hoists, he could construct the two conveyors out of stock on hand, and presumably knew that they would operate satisfactorily. Unfortunately, the conveying apparatus broke down very frequently, and, unless repairs were made within a few minutes, the concrete in the bucket conveyor began to set, thus causing serious delay while men chopped the buckets and operating mechanism clear.

When the apparatus was in working order, however, no better scheme could have been desired. It was possible to place the concrete in any portion of the floor, the walls, the posts, or the ties, without any further handling. As there was a clause in the specifications which permitted the use of wet concrete, the trough system of chuting the concrete was an admirable plan.

Pocket No. 2 has a capacity of 1 600 tons. Its dimensions are about 62 by 46 ft., over all, and its height to the top of the ridge is 60 ft. 10 in. It is constructed in such a manner as to allow for further additions longitudinally.

On account of the difficulty encountered in placing concrete in Pocket No. 1, it was decided to make No. 2 of concrete only as far as the foundations and floor. As shown by Plate CLXXIII, this portion contains really mass concrete, which was easily put in place.

The remainder of Pocket No. 2 is of timber, and all the timber used as falsework for the concrete construction was afterward embodied in the pocket itself, so that the cost of material for forms was very small.

The pocket rests on four lines of columns, nine in a row, the rows being 16 ft. 8 in. from center to center, so as to allow plenty of room for large coal wagons. The ends of the pocket overhang 5 ft. from the centers of the last line of columns. The columns are 15 by 20 in. in cross-section except the center one in each row, which is 18 by 20 in., the former being reinforced with four ⅞-in. round rods, with ⅜-in. hoops, and the latter with four 1-in. rods, with ⅜-in. hoops. The columns rest on concrete footings carried on piles.

The concrete beams spanning the columns are 15 or 18 in. wide and 34 in. deep. They are reinforced in different ways, on account of their location, but in general have eight 1-in. rods at the bottom at the centers of the beams.

The floor-slab is 6½ in. deep, and is reinforced every 6 in. in a direction at right angles to the main beams, by two ½-in. rods, spaced 1 in. from the top and bottom of the slab.

The timber portion of the pocket is of the usual type of construction, with timber tie-rods through the bins, and timber rods all around the exterior of the vertical studding, as shown by Figs. 1 and 2.

Coal is unloaded from barges at the end of the pier by a clam-shell bucket mounted on a revolving Browning locomotive crane, and is deposited in a hopper from which it is carried to the top of the pocket on a conveyor, supported on a timber trestle.

The method of placing the concrete in this pocket was adopted because the locomotive crane and clam-shell bucket had been delivered to the owners before concreting was commenced, and the contractor was permitted to use them. The clam-shell bucket unloaded the sand and gravel from the deck barges into carts which in turn unloaded the material near the batch mixer close to the pocket.

The concrete mixer had elevated storage bins, and after a boat load of material had been unloaded, the locomotive crane was moved down to the mixer and, with the clam-shell bucket, hoisted the sand and gravel into the bins. Then, when concreting was in progress, the output of the mixer was deposited directly in the same clam-shell bucket, now free from the duty of placing the raw materials. The boom of the crane was of sufficient length to deposit concrete in any part of the pocket. The concrete was dumped by the engine runner, who controlled every motion of the bucket. The scheme was most successful.

PLATE CLXXI.
PAPERS, AM. SOC. C. E.
OCTOBER, 1910.
FALK ON
REINFORCED CONCRETE COAL POCKETS.

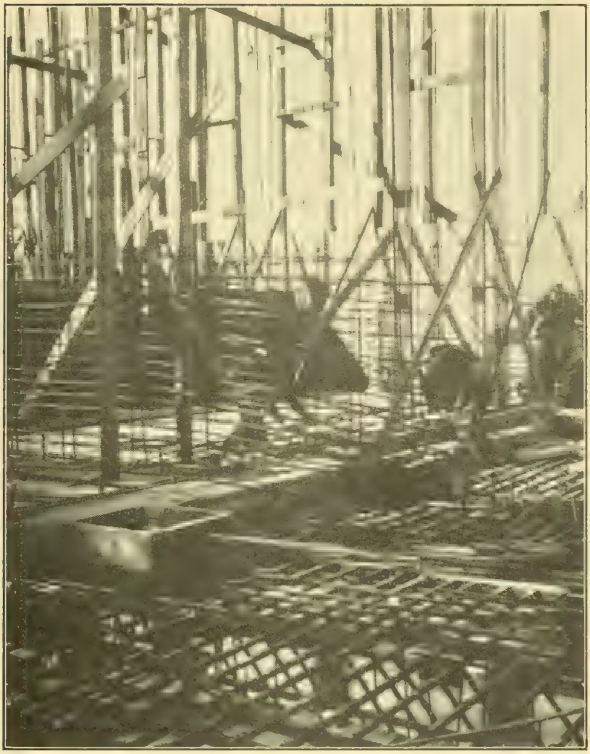


Fig. 1.—Reinforcement for Coal Pocket No. 1.

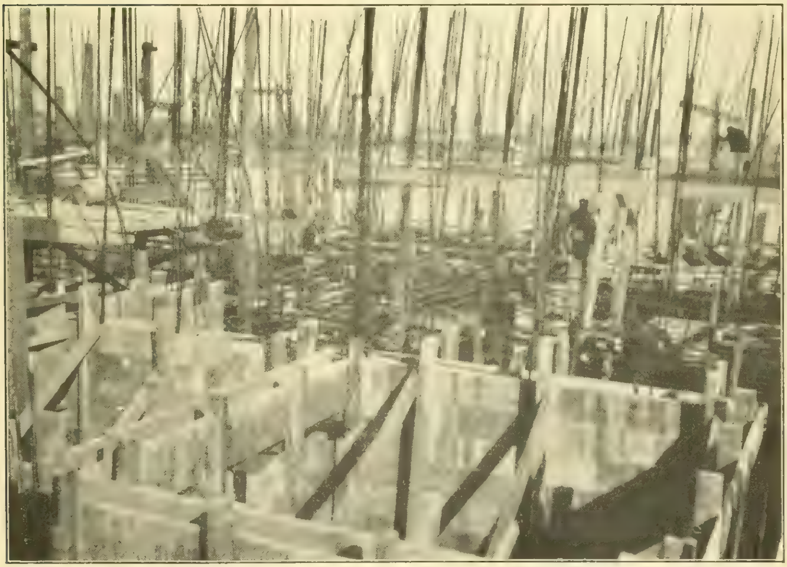


Fig. 2.—Reinforcement for Coal Pocket No. 1.

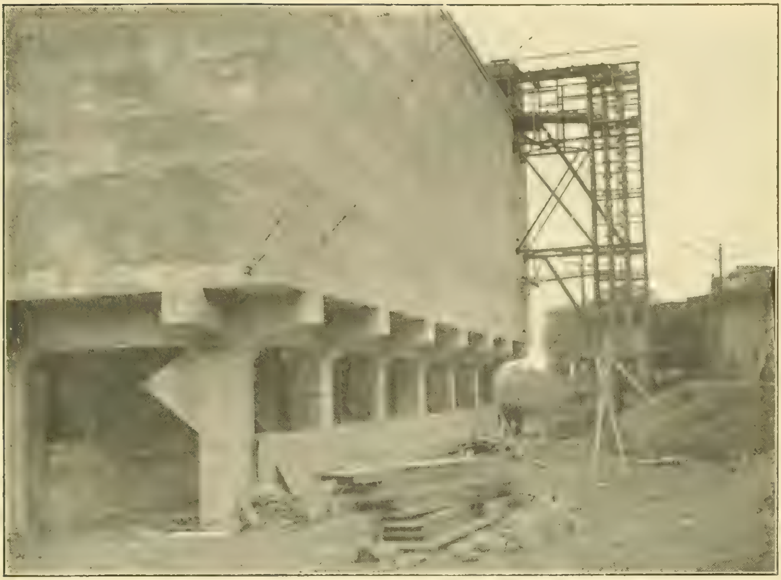


Fig. 1.—Corner of Coal Pocket No. 1.

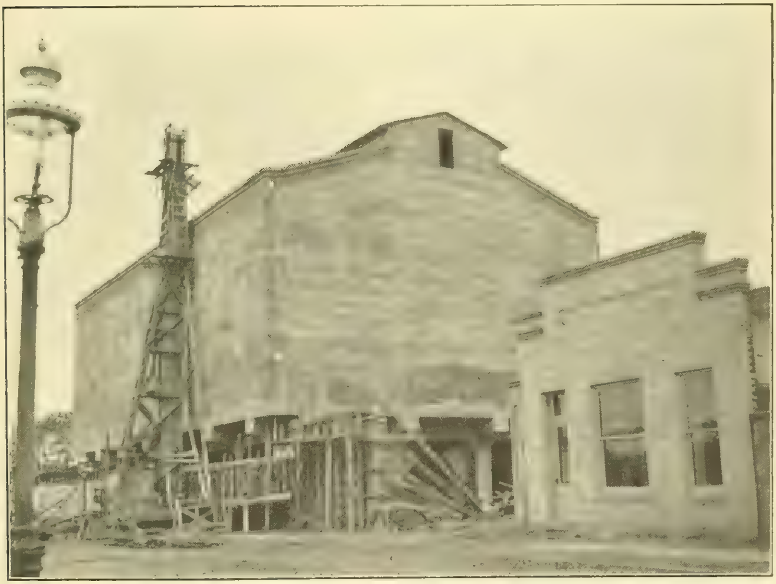
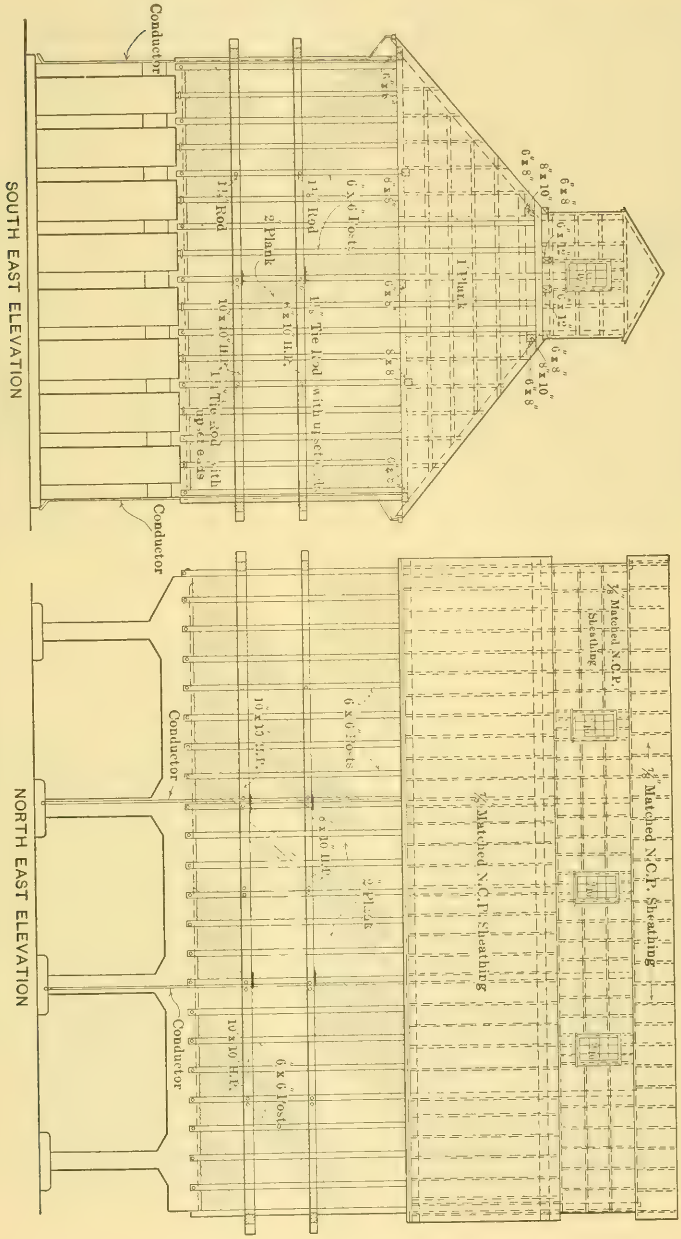
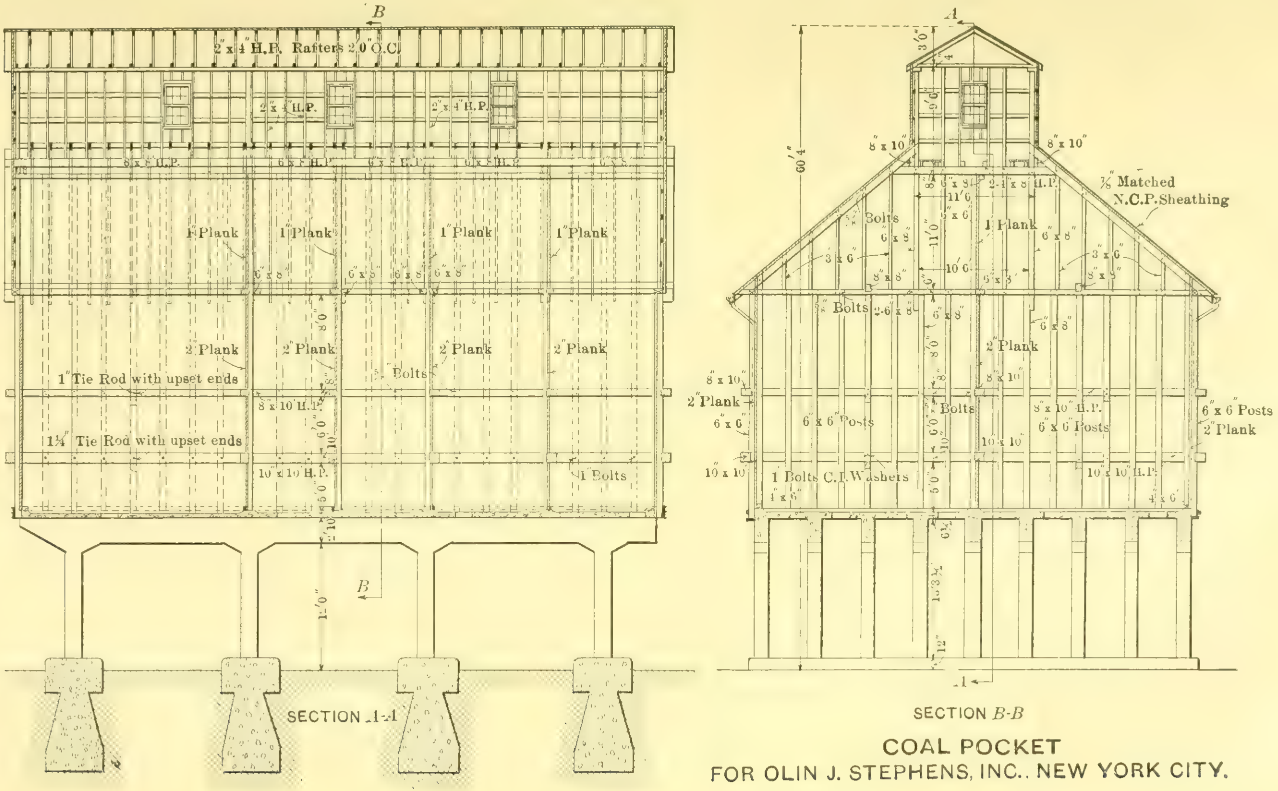


Fig. 2.—Coal Pocket No. 1. Completed.



COAL POCKET FOR OLIN J. STEPHENS, INC.
NEW YORK CITY
Fig. 1.



SECTION A-A

SECTION B-B

COAL POCKET
FOR OLIN J. STEPHENS, INC., NEW YORK CITY.

FIG. 2.

PLATE CLXXIII.
PAPERS, AM. SOC. C. E.
OCTOBER, 1910.
FALK ON
REINFORCED CONCRETE COAL POCKETS.

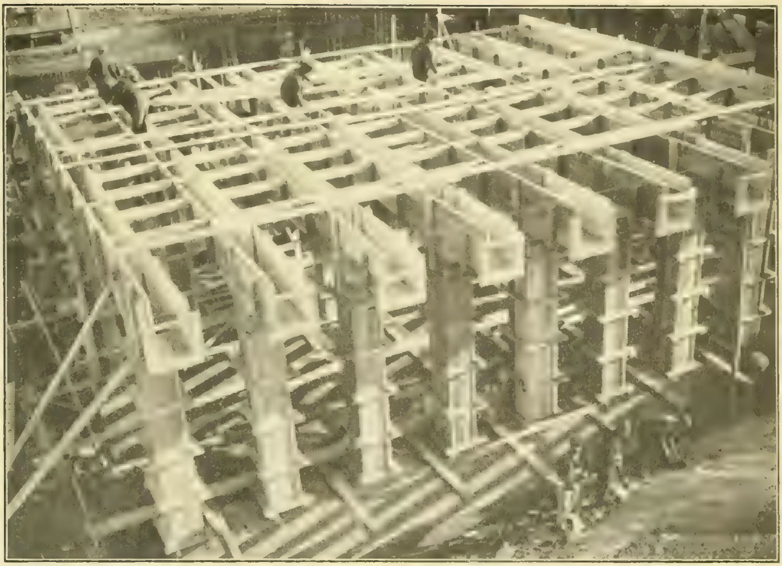


Fig. 1.—Forms for Concreting, Coal Pocket No. 2.

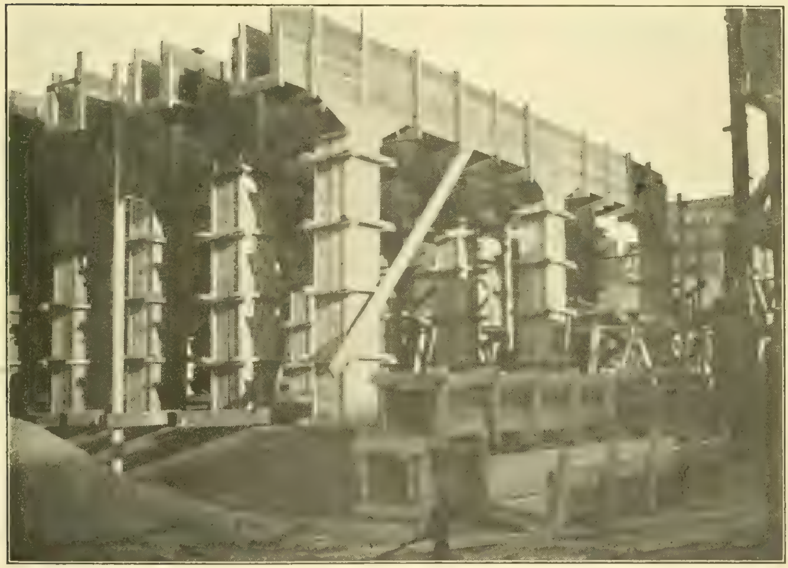
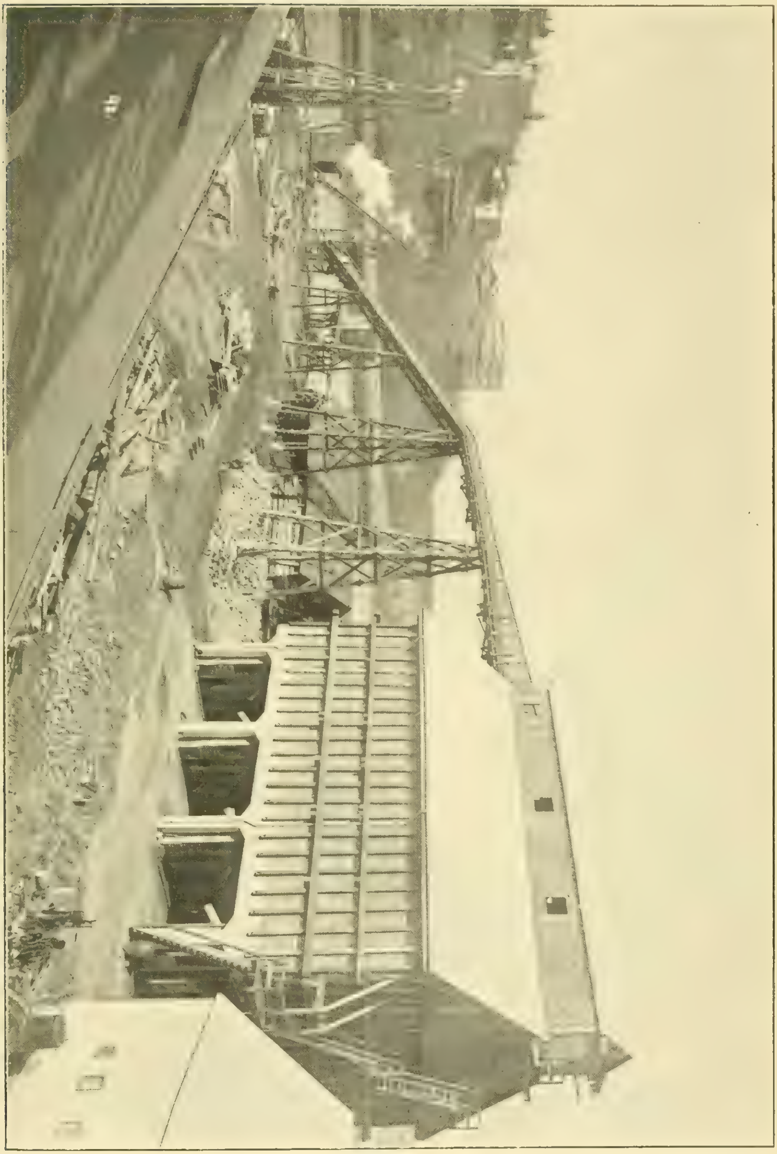
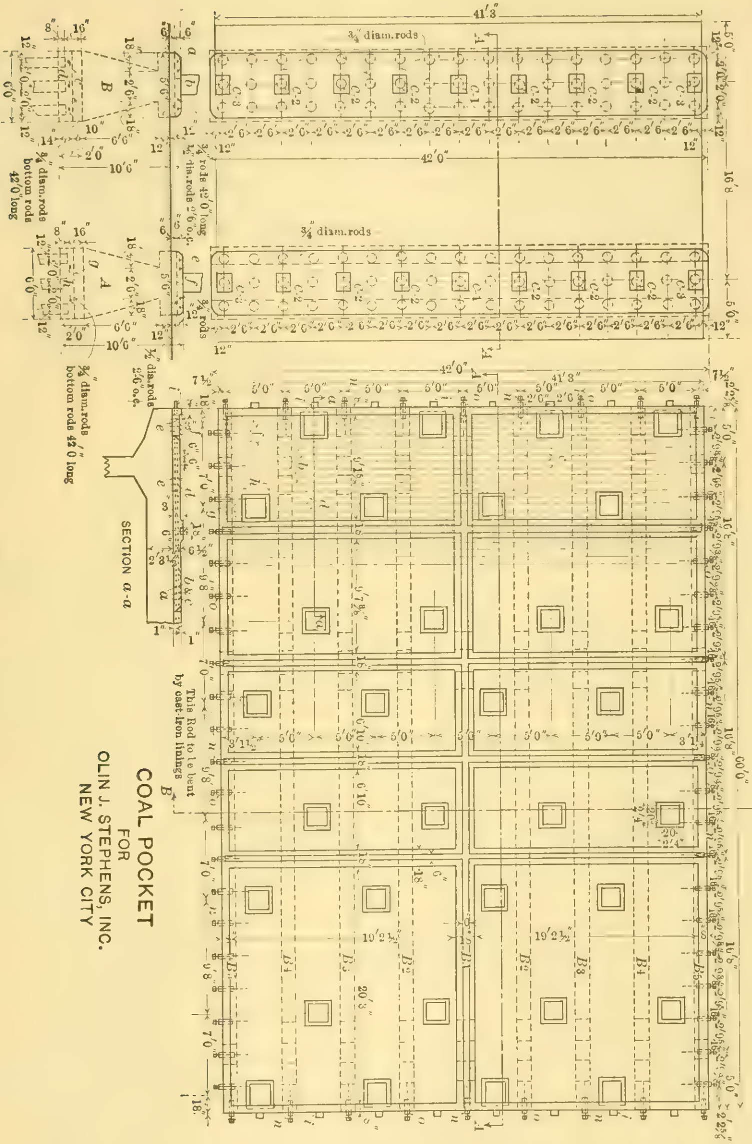


Fig. 2.—Forms for Concreting, Coal Pocket No. 2.

PLATE CLXXIV.
PAPERS, AM. SOC. C. E.
OCTOBER, 1910.
FALK ON
REINFORCED CONCRETE COAL POCKETS.



COAL POCKET NO. 2 AND CONVEYOR.



COAL POCKET
FOR
OLIN J. STEPHENS, INC.
NEW YORK CITY

FIG. 3.

The vertical studding forming the sides of the pocket rests on T-irons embedded in the concrete beams; the studding is also held by bolts, as shown by Fig. 3.

The actual cost figures of these two pockets are not of general value, as the local conditions at the sites of the buildings were so totally different. It is sufficient to say that, compared with Pocket No. 1, it is the writer's opinion that Pocket No. 2 furnishes a type of structure which is more easily erected, uses cheaper material throughout, and furnishes a building which, viewed from all standpoints of an owner, is entirely satisfactory.

Vol. XXXVI. OCTOBER, 1910. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

REMEDIES FOR LANDSLIDES AND SLIPS ON THE KANAWHA AND MICHIGAN RAILWAY.

Discussion.*

By Charles H. Miller, M. Am. Soc. C. E.

Charles H. Miller, M. Am. Soc. C. E. (by letter).—The problem of dealing with landslides generally is a most difficult one. It is impossible to give any fixed plan, because, in each particular case, all the local conditions must first be carefully considered. Mr. Miller.

The remedies described by the author have been in existence much too short a time to determine their permanency, and he fails to state whether or not they are intended to be so. It often happens that the life of a temporary structure is of sufficient length to justify its use, and the ones described may have been constructed for this reason.

In carrying out these remedies, as far as can be learned, very little, if any, effort was made to get at and remove the source of the trouble.

At Cannelton, W. Va., sole reliance seems to have been placed on a double row of braced piling to hold back a mass of moving material extending up the slope about 380 ft. and having a depth averaging at least 30 ft. A part of this mass was removed near the toe, or just above the piling. The writer can readily understand how the sliding at this point may be checked by making the new slope flatter than the old one, but is in doubt as to whether the flattening was extended far enough up the slope to prevent the wet material above from again sliding down over the new slope and finally over the top of the pile retaining wall.

---

*This discussion (of the paper by R. P. Black, Assoc. M. Am. Soc. C. E., printed in *Proceedings* for May, 1910, and presented at the meeting of September 7th, 1910), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

Mr. Miller.

At the Brighton slip, the assumption seems to have been made that, by driving the piles into a rock bottom, they would get a toe hold sufficient to prevent further sliding of the mass above. First, what assurance is there that the iron straps, placed on the points of the piles for the purpose of causing them to penetrate the rock, do not defeat this very purpose, by cutting into the points and aiding the battering of the same? Assuming that the points get a good toe hold, what is to prevent them from bending over as the mass moves down the slope from above? Is it not possible that success, if obtained in this case, is due to the fact that sub-drainage occurs down each of the piles, which are only 3 ft. apart, thus conducting the water to a stratum through which it passes to the river without causing movement, thus permitting the mass below the upper row of piles to dry out and become stable?

To correct the trouble at this point, it would seem well, first, to protect the toe of the slope with mattress or rip-rap so as to be certain that the river could not continue scouring off the support to the mass above; next, to excavate a trench along the upper side of the track, making it of such depth as to get below the movement at all points, and place therein a tile drain, the entire trench to be then filled with cinders; and, finally, to place surface drains well above the limits of the movement.

The Cannelton situation is a much more difficult one to meet, but good surface drains should be placed around the top of the movement, in stable material, where they will not require much maintenance if constructed with proper slopes. Drainage ditches should be placed around over the slide and given much close attention. It is not economical to attempt general ditches, but the water-pockets and low places should be drained quite often, especially after each hard rain. The chief difficulty to-day is in getting the section foreman to realize how much work he can relieve himself of in the end by frequent and careful attention to drainage.

The claim that roots or vegetation will hold, in place, mucky clay from 8 to 20 ft. deep, on a slope—or will have any appreciable effect whatever in that direction—is not a good one.

Blasting up the surface of the rock on which there is sliding earth does not stop the sliding because of the roughened surface, but because a passageway is made for the water, enabling it to get away from the clayey material above, thus allowing it to dry out.

It often proves economical in the end to abandon the old line and relocate where a solid foundation can be secured. In all extensive slides it is well to take a sufficient number of accurate borings before planning a remedy.

Vol. XXXVI. OCTOBER, 1910. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE TIETON CANAL.

Discussion.*

By Horace W. Sheley, Assoc. M. Am. Soc. C. E.

Horace W. Sheley, Assoc. M. Am. Soc. C. E. (by letter).—The subject of the loss of carrying capacity of a canal, due to algæ, or "moss," is increasingly important, owing to the growing use of concrete linings, which are expected to give low coefficients of friction and consequent high velocity. This expectation is not realized when the growth of algæ is excessive. The writer has in mind one concrete-lined channel which, since algæ have grown in it, carries only 400 sec-ft., at a certain stage, as compared with a clean-channel flow of about 660 sec-ft., a loss of 40 per cent. The vertical velocity curve at the section of maximum velocity, in Fig. 3, shows that algæ are the cause of still water in the bottom half-foot of the channel, and that they decrease the velocity above, owing to the surging and cross-currents which they cause. As this canal was lined with concrete at great expense, in order to increase the capacity to a certain necessary quantity, the loss is a serious matter. Mr. Sheley.

In one of the earliest water supply papers of the United States Geological Survey, the Honorable Samuel Fortier states that algæ cause losses in carrying capacity altogether disproportionate to the area of the cross-section of the channel occupied by them.

In the case cited, the canal is so large that it would be difficult to scrape off the algæ without drawing off the water for some days; therefore, scraping would be a costly solution of the problem, and legally inexpedient. Further, algæ often reappear shortly after having

---

* This discussion (of the paper by E. G. Hopson, M. Am. Soc. C. E., printed in *Proceedings* for August, 1910, and presented at the meeting of October 5th, 1910), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

Mr. Sheley.

been scraped off, so that many treatments might be necessary in a season. Therefore a solution of the question, which would not involve stoppage of the flow of the canal during the irrigation season, would be timely.

Blue vitriol, or copper sulphate, has been used with great success to kill algæ in municipal reservoirs, and might be applied to irrigation canals. Messrs. George T. Moore and Karl F. Kellerman state* the quantity of the salt required for various kinds of algæ, but do not mention the genus said to be *Cladophora,* a long-fibered variety, which probably causes the most trouble in irrigation canals. The *Cladophora* is said to be closely related to the *Conferva Bombycinum* which requires 1 part of copper sulphate to 1 000 000 parts of water. However, since it appears, from a list given by these authors, that in estimating the necessary proportion of copper sulphate, little reliance can be placed on the similarity of the plants, less copper sulphate or much more than 1 : 1 000 000 might be required for the desired effect.

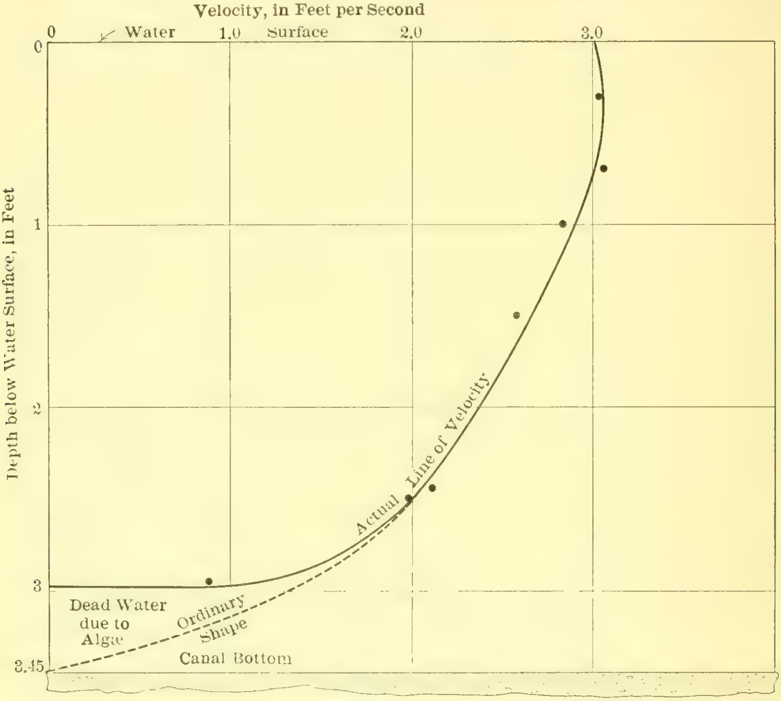


FIG. 3.

Assuming that the proportion is 1 to 1 000 000, 5.4 lb. per sec-ft. every 24 hours of treatment would be necessary. Copper sulphate

---

* Bulletin No. 64, Bureau of Plant Industry, U. S. Dept. of Agriculture.

Mr. Sheley.

sells wholesale at present for $4 per cwt., so that the cost for the salt would be 2.16 cents per sec-ft. for 24 hours, exclusive of labor charges. Assuming the necessity for three treatments, with the total of five days, during the irrigation season, the cost for the sulphate would be 10.8 cents per sec-ft., or, say, from 0.10 to 0.15 cent per acre of land irrigated.

The strength necessary to kill this alga might be much greater—even twenty times as great—and the inflow of moss from the feeding stream would tend to start the new growth more rapidly in an irrigation canal than in a municipal reservoir; but it is likely that only occasional treatments would be necessary.

The writer does not know what effect copper sulphate would have on crops grown by irrigation, but it seems probable that the copper would be precipitated out of solution, as a hydrated oxide or basic salt, in the laterals before reaching the crops.

If treatment with copper sulphate proves impractical, either on account of the expense or the injury to crops, another method, which has occurred to the writer, might prove feasible. This method is based on the well-known fact that algæ are lovers of light, and must have it in order to grow well. For example, in the concrete-lined canal of the Arizona Power Company, it was found that they grew only in the open canals and not in the tunnels, though the velocity was about the same in each.

Therefore, anything tending to diminish the light would decrease the growth of algæ, and it is likely that it would be materially decreased if the concrete-lined section of a canal were painted a dull black with a thin coat of asphalt, tar, elaterite, or some other black, light-absorbing substance; for it has been observed that algæ grow in profusion on white objects and to a much less extent on dark ones. No ordinary stream velocity stops the growth, but they do not thrive in water carrying much silt. They grow quite freely even in rather cold waters.

Vol. XXXVI. OCTOBER, 1910. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

RUST, AS SHOWN IN THE REMOVAL OF A SEVENTEEN-STORY BUILDING.

Discussion.*

By E. L. Verveer, Assoc. M. Am. Soc. C. E.

Mr. Verveer. E. L. Verveer, Assoc. M. Am. Soc. C. E. (by letter).—This paper calls to mind some causes of the rusting of steel in modern buildings which are deduced from the writer's observations of structures in the course of erection.

Specifications very often require steel columns to be encased with a layer of cement mortar before the surrounding brick, stonework, or other fire-proof material, is put in place. This is done to prevent the steel from oxidizing by coming in contact with moisture, and is an additional precaution, as paint itself is not an absolute preventive.

The owner, being anxious to have the building ready for occupancy as soon as possible, so that he may derive an income from his investment to meet his fixed charges, inserts a time limit in the contract; or, in other words, the contractor is bound by a "time clause," which, if not adhered to, leads to "liquidated damages." Consequently, the work must be speedily done. The cement mortar may be placed around the surfaces of the steel, as required by the specifications, the workman keeping ahead of the mason or bricklayer, as the case may be. Not being thoroughly dry, or perhaps having been struck by objects coming in contact with the column, pieces of the mortar fall off, and, as the work of the other trades proceeds so rapidly, they are not replaced. The steel column, then, at these bare spots, is exposed to the moisture or moist air which, from one cause or another, may creep in, thus creating the condition mentioned in the third paragraph of Mr. Thomson's paper. Mr. Verveer.

---

* This discussion (of the paper by T. Kennard Thomson, M. Am. Soc. C. E., printed in *Proceedings* for September, 1910, but not presented at any meeting), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

It does not seem to the writer that sufficient care is taken in the construction of party walls or walls adjoining adjacent buildings. It may be that, because hidden from view, any construction is thought to be permissible. Whether or not this is the case, the brick is quite often improperly laid, and insufficient mortar is placed in the joints, so that air spaces exist. Then, too, the mortar, after drying, sometimes shrinks away from the brick, or a slight settlement of the building may cause voids at the joints. The bricks also may absorb the moisture, leaving the mortar to crumble away. In any case, these conditions permit the moisture or moist air to reach the steel columns and beams in the wall and to promote oxidation.

Property lines frequently overlap existing buildings, so that it is not possible to make the party wall of the required thickness. Where columns occur in such walls, there is often only 4 in. left between them and the wall of the adjoining property. In such cases only a single brick can be placed against the column face, and there cannot be a good bond. Again, with only a small space in which to work, the bricks are not properly laid, and the steel is practically exposed.

In several cases where an old building abutting a modern steel one has been torn down to give place to a new steel structure, the single layer of bricks forming a face for the wall columns has toppled over when the side walls of the old building were razed, leaving the steel exposed. This was good evidence that the bricks were not well bonded and did not serve to protect properly the paint on the steelwork, in other words, did not help to prevent oxidation.

In the best practice, the underside of the flanges of steel floor-beams is covered with 2 in. of some kind of concrete. The object of this is to prevent the flames, in case of fire, from acting directly on the beam, and also to protect the steel from rusting. Often, however, the flange is simply covered with wire mesh and the plaster applied to this. Plaster is porous and readily absorbs moisture and, consequently, does not of itself protect the flange from rusting, but rather helps the oxidation by being a vehicle. The paint is then the only protection for the steel, and, as paint is not an absolute preventive, the steel flanges will rust in time. This, perhaps, is why the undersides of the flanges of floor-beams frequently show signs of rust.

The writer does not believe that there is any absolute preventive of the oxidation of steel, known at the present time, which can be commercially applied, and, consequently, he deems it a mistake to think that steel encased in brick, cement, paint, etc., will not require inspection from time to time.

MEMOIRS OF DECEASED MEMBERS.

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

WILLIAM FOSTER BIDDLE, M. Am. Soc. C. E.*

Died August 10th, 1910.

William Foster Biddle was born in Philadelphia, Pa., on August 18th, 1834. He was graduated at the University of Pennsylvania in 1852, and took up the practice of engineering. He held successively the positions of Leveler on the Virginia Central Railroad (now the Chesapeake and Ohio), under Charles Ellet, Jr., up to 1855; Resident Engineer in charge of Construction on the Mine Hill and Schuylkill Haven Railroad (now the Philadelphia and Reading), up to 1857; Assistant to the Chief Engineer of the Illinois Central Railroad at Chicago, up to 1860; and Superintendent of the Eastern Division of the Ohio and Mississippi Railroad, at Cincinnati, up to October, 1861.

In 1862 and 1863 he was in active military service in the Civil War, with the rank of Captain (on the staff of General McClellan, with whom he had been previously associated in engineering). His record of service with the Army of the Potomac, from its formation until after the battle of Antietam, was that of a brave and gallant officer.

He was Superintendent of the Freedom Iron Works, Pennsylvania, up to 1865, and was Vice-President of the Lehigh Coal and Navigation Company (Lehigh and Susquehanna Railroad), until 1869. In 1874 and 1875 he designed, located, and constructed mining water-works in Venezuela, South America. Later, he was President of the Millwood Coal and Coke Company, of Westmoreland County, Pa., with offices in Philadelphia.

Captain Biddle was ill for several months following an attack of acute pleurisy, in March, from which an empyema developed, necessitating an operation for the abscess which had formed in the pleural cavity, and from the effects of which he never recovered, septicæmia setting in. He died at South Bethlehem, Pa., at the home of his niece, Mrs. Henry S. Drinker.

Captain Biddle was a cultured gentleman, a man universally respected and greatly loved by those privileged to know him well. He was an able engineer, and, in addition to his membership in this Society, was an active member of the American Institute of Mining Engineers, and of the Union League Club of Philadelphia. His charm-ing personality is best summed up in the following tribute to his memory which appeared in the *Philadelphia Ledger* of August 12th, 1910, which will be appreciated by all who knew him:

---

* Memoir prepared by Dr. Henry S. Drinker, President, Lehigh University, and Mr. James McCrea, President, Pennsylvania Railroad Company.

> "A distinguished figure is lost to the finer life of Philadelphia in the death of Captain William Biddle. Though he had long passed his threescore years and ten, no one ever had thought of him as an old man. His handsome face, his gentle speech, his whole gracious personality had the charm of perennial youth. A gallant soldier in the Civil War, an engineer of achievement, and always an active-minded citizen, his persistent personal vocation really was in music. Few musicians are as well-read as he in the literature of the pianoforte, and for many years there has been no one in Philadelphia more confidently to be counted upon for the support of all laudable musical undertakings. He was the musical editor of a hymnal that is a model of musical exactitude and taste not often found in such compilations. Until the past winter he was seldom missing from any important concert, and his absence will leave a gap not easily to be filled by one of his fine attainments, his gentle breeding, and his serene character."

Captain Biddle was elected a Member of the American Society of Civil Engineers on June 4th, 1884.

CLARENCE ALLEN CARPENTER, M. Am. Soc. C. E.*

DIED NOVEMBER 9TH, 1899.

Clarence Allen Carpenter, the only son of John Allen Carpenter, was born at Dedham, Mass., on August 26th, 1846. His father was a well-known contractor, having been connected with the construction of the Fitchburg Railroad, the Old Colony Railroad, the Lawrence Dam, and many other important engineering enterprises.

In 1863, when he was seventeen years old, Mr. Carpenter began his professional career as Chainman on the Adirondack Railroad. He was successively Rodman, Leveler, and Transitman, remaining with the company until 1865. From 1865 to 1867, he was in the service of the Whitehall and Plattsburgh Railroad, attaining the position of Assistant Engineer.

In March, 1868, Mr. Carpenter entered Union College at Schenectady, N. Y., intending to take the course in Civil Engineering, but he was obliged to leave in February, 1869, on account of his eyes.

From May to November, 1869, he was Assistant Engineer of construction on the Neosho Branch of the Missouri, Kansas, and Texas

---

* Memoir prepared by the Secretary from papers on file at the Society House and from a memoir published by the Association of Engineering Societies.

Railway. From February, 1870, to May, 1871, he served as Assistant Engineer in charge of construction on the Little Rock and Fort Smith Railroad, and from May to October, 1871, he was engaged on the survey for the Southern Pacific, west from Van Buren.

In November, 1871, Mr. Carpenter returned East, and until June, 1872, was in the employ of the New York and Boston Railway as Assistant Engineer on construction. For the next four years (1872-1876) he was Assistant and Resident Engineer, respectively, for the Delaware and Hudson Canal Company, on the construction of the New York and Canada Railway.

From March, 1877, to March, 1878, Mr. Carpenter was engaged, as Contractor and Engineer, with the Sewer Department at Saratoga Springs, N. Y., and from March to November of the same year, he was employed as Assistant Engineer, in charge of the west end of the Plattsburgh and Dannemora Railroad, which was built by the State of New York.

In March, 1879, Mr. Carpenter again went West to the Central Branch of the Union Pacific Railway as Assistant Engineer in charge of construction, and in June, 1880, he entered the employ of the Chicago, Milwaukee, and St. Paul Railway, remaining with that road for eleven years and attaining the position of First Assistant Engineer.

After severing his connection with the Chicago, Milwaukee, and St. Paul Railway Company, Mr. Carpenter was engaged on surveys for the Atchison, Topeka, and Santa Fé System, in California, until he accepted the position of Division Engineer on the Northern Pacific Railroad, with headquarters at Helena, Mont.

In the fall of 1891, he was appointed Division Engineer of the Lake Shore Division of the Lake Shore and Michigan Southern Railway, which position he held at the time of his death. While attending to his duties, Mr. Carpenter was struck by a passenger train near Geneva, Ohio, on November 7th, 1899, and died from the effects of his injuries on November 9th.

Although quiet and unassuming in his manner, Mr. Carpenter was universally beloved and respected by all who knew him, for his personal qualities and his ability as an engineer. His reputation for care and accuracy was widespread. He had a rare capacity for detail, nothing connected with his work being of too little importance to claim his careful personal attention. He also had a broad and comprehensive grasp of the greater problems, which always won the confidence of his employers.

Mr. Carpenter was elected a Member of the American Society of Civil Engineers on May 2d, 1888. He was also a Member of the Civil Engineers' Club of Cleveland, Ohio.

GEORGE EARL CHURCH, M. Am. Soc. C. E.*

DIED JANUARY 5TH, 1910.

George Earl Church was born in New Bedford, Mass., on December 7th, 1835. He was of Puritan ancestry, and it is said that "he carried in his veins the bluest blood of New England." On his father's side he was directly descended from Richard Church, who, in 1632, went from Oxford, England, to Plymouth, Mass., where he married Elizabeth Warren, whose father, Richard Warren, came to America on the *Mayflower,* and was an ancester of General Warren, who fell at Bunker Hill. On his mother's side he was a lineal descendant of a daughter of Edward Winslow, who also came to Plymouth on the *Mayflower.*

While Mr. Church was quite young, his father died, and in his eighth year his mother moved to Providence, R. I. Here he attended the public schools, and at the age of fourteen held high rank in the Senior Class of the High School. When he was seventeen he decided to follow the profession of civil engineering.

In 1853 and 1854 he was engaged as Assistant Topographical Engineer on the State map of Massachusetts. In 1855 he was employed as Assistant Engineer on the Mississippi and Iowa Central Railway. In 1856 he was appointed Resident Engineer on the Hoosac Tunnel, but, when this great work was suspended for a time, he returned to Iowa as Chief Assistant Engineer on the location of a long line of railway in that State.

The financial crisis of 1857 having put a stop to the work, Mr. Church accepted an offer to carry out a railway project in the Argentine Republic as Chief Engineer, but on arriving in Buenos Aires, he found the country in such a disturbed condition that the work had to be postponed. The Government, however, almost immediately, appointed him a member of a scientific commission to explore the southwestern frontier and report on the best system of defence against the fierce inroads of Patagonian and Araucanian savages and allied tribes from the Andean slopes.

In 1860 Mr. Church surveyed and located the Great Northern Railway of Buenos Aires, and acted as Chief Assistant Engineer during its construction in 1860 and 1861. At the outbreak of the Civil War in the United States he gave up his position in Buenos Aires and embarked for New York on an American schooner. Reaching home, he was commissioned as a Captain in the Seventh Rhode Island Infantry, and was sent to the front.

During the war he served successively as Captain and Lieutenant Colonel of the Seventh Regiment, and as Colonel of the Second and

---

* Memoir prepared by the Secretary from information on file at the House of the Society.

Eleventh Regiments, Rhode Island Volunteers, and as a Brigade Commander, in the Army of the Potomac. He earned especial distinction at the Battle of Fredericksburg, where his regiment suffered very great losses. He entered the fight as a captain and came out of it as lieutenant colonel in command of the remnant of his regiment. Afterward he was promoted to the colonelcy of the Seventh Rhode Island Infantry, and was sent to the Virginia Peninsula. He was present at the siege of Suffolk by Longstreet, and, later, commanded a brigade in a raid for the tearing up of the Norfolk and Petersburg and the Seaboard and Roanoke Railways, which was accomplished successfully after several hot skirmishes. He was then placed in command of the fortifications of Williamsburg until the term of his regiment expired.

At the close of the war Colonel Church was appointed Chief Engineer of the Providence, Warren, and Fall River Railway, which road, though presenting some difficult engineering problems, he constructed during 1865 and 1866.

In 1866 and 1867 he served in Mexico, and planned the campaign which resulted in the capture of Maximilian. During this campaign he also acted as war correspondent, and in 1868 was an Editor on the *New York Herald.*

In 1868 he went again to South America, and in a series of journeys explored a large part of the upper basin of the Amazon. He also explored the Bolivian affluents of that river, and was engaged for several years in opening up new channels for trade between Bolivia and Brazil. From 1872 to 1879 he was President of the National Bolivian Navigation Company and Chairman of the Madeira and Mamoré Railway Company.

In 1880 Colonel Church was appointed United States Commissioner to visit Ecuador and report on political, financial, and trade conditions in that country. His report, "Ecuador in 1881," was published as a special message of the President to Congress.

Probably his greatest work was in connection with the Madeira and Mamoré Railway, on which, for ten years, at the invitation of the Government of Bolivia, he devoted his attention. He conducted negotiations with European capitalists and with the Brazilian Government, and if it were possible here to give in detail the incidents of this period of his career it would form an interesting prelude to the history of that great railway which is now under construction, and is a tribute to his foresight and technical capacity.

In later years he took up his residence in London, England, where he associated himself with Argentine railway companies and engaged in literary pursuits, devoting much time to the study of the South American aborigines. As a writer and speaker on subjects connected with his life works, Colonel Church was a recognized authority, and his contributions to the researches of scientific societies are standards for the student. Although residing in England, his loyal Americanism was always a prominent element in his character. He died in London, on January 5th, 1910, and was buried in Brompton Cemetery.

Colonel Church was twice married; his second wife, who survives him, was the widow of Mr. Frederick Chapman and a daughter of Sir Robert Harding.

Colonel Church was a Companion, first class, of the Military Order of the Loyal Legion, of the United States. For many years he was a member of the Council of the Hakluyt Society, and also of the Royal Geographical Society, having been Vice-President of the latter for a period of four years. It is said that he was "the first man, not a British subject, ever admitted to the honor of a seat in its council." He was a frequent contributor to the Society's *Journal,* and took part in most of the discussions on papers dealing with South American subjects. At the Bristol Meeting of the British Association for the Advancement of Science, in 1898, he was President of the Geographical Section, the subject of his presidential address being "Argentine Geography and the Ancient Pampean Sea." He was also a member of the Royal Historical and of the Royal Anthropological Institute of Great Britain and Ireland.

Colonel Church probably possessed a wider and more complete knowledge of the history, geography, and resources of South America than any other authority. The information he acquired by his own extensive travels in the heart of the continent was supplemented by a lifetime of study of the experiences of other travelers. He followed closely the development of the Panama Canal scheme, and was strongly of the opinion that the construction of the canal was not justified on commercial grounds. A few years ago, when various projects for the building of a new railway across Canada were under consideration, he was actively interested in a scheme for a line to follow a more northerly route than that of the Grand Trunk Railway.

Colonel Church was elected a Member of the American Society of Civil Engineers on November 2d, 1887.

WILFRED EMORY CUTSHAW, M. Am. Soc. C. E.*

DIED DECEMBER 19TH, 1907.

Wilfred Emory Cutshaw was of Scotch descent and was born at Harper's Ferry, Va., now West Virginia, on January 25th, 1838. His father was George W. Cutshaw, a native of Loudoun County, Virginia, who died in 1887. His grandfather was John W. Cutshaw, a Maryland farmer, who was a veteran of the War of 1812. Mr. Cutshaw's mother, Martha J. Moxley, was born in Alexandria, Va., and was of English ancestry.

---

* Memoir prepared by the Secretary from papers on file at the House of the Society.

Mr. Cutshaw, after preparation at home and at a local academy, entered the Virginia Military Institute, at Lexington, from which he was graduated in 1858, with a good knowledge of civil and military engineering. After teaching for one term in an academy in Loudoun County, he became, in 1859, an Instructor in the Hampton Military Institute, and remained there until the spring of 1861, when he resigned to enter the service of the Confederate Army.

In April, 1861, Mr. Cutshaw was made a First Lieutenant, and assigned to a battalion of artillery in the Brigade of General T. J. Jackson. In the spring of 1862 he was made Captain of Artillery; in the fall of that year he became Major, and in February, 1865, he was made Lieutenant-Colonel.

Colonel Cutshaw's war record was exceptionally brilliant. He participated in the operations of General Magruder in the Peninsula, in the summer of 1861, and in the campaigns of Jackson in the Valley, in the spring of 1862, in which he commanded a battery in the battalion of Colonel Crutchfield, taking part in several vigorous engagements. In the Battle of Winchester, in May, 1862, he was severely wounded, a bullet piercing his left knee, and was captured by the Federal forces. He remained a prisoner until April, 1863, when he was exchanged.

A medical examining board having pronounced him unfit for active duty, he was assigned as Acting Commander of Cadets at the Virginia Military Institute, a position which he held until September, 1863, when he applied for readmission into the Confederate Army and was accepted, notwithstanding the fact that his wound was unhealed. He was assigned to duty as Inspector-General of Artillery, Second Corps, Army of Northern Virginia, and participated in a number of battles in 1863 and 1864. In the Wilderness of Spottsylvania, in 1864, while in command of a battalion of artillery, he received a slight wound in his right arm. In February, 1865, he became Lieutenant-Colonel of Artillery, in which capacity he served until April of that year, when, in the Battle of Sailer's Creek, just three days before the surrender at Appomattox, he was wounded, and the next morning his right leg was amputated between the knee and the hip. While lying wounded, Colonel Cutshaw gave his final parole, after a record of the most gallant and self-sacrificing service. His name is identified with Cutshaw's Battalion, one of the most serviceable and famous in the artillery arm of the Confederate service.

For a year following the close of the war Colonel Cutshaw engaged in temporary pursuits. In September, 1866, he was appointed Assistant Professor of Mathematics in the Virginia Military Institute, the position held previous to the war by Major, afterward General, T. J. Jackson.

In January, 1868, he was appointed assistant to Mr. Charles P. Stone, Engineer and Superintendent of the Dover Coal and Iron Company, of Henrico County, Virginia. He still continued his connection with the Virginia Military Institute, as Professor of Mathematics, becoming, in 1871, Professor of Civil and Military Engineering, which position he held until the fall of 1873, when he was elected City Engineer of Richmond, Va. The latter position he filled ably for more than thirty-four years.

During his service as City Engineer of Richmond, Colonel Cutshaw saw the city practically rebuilt, and the last traces of the ravages of war obliterated. In this work he encountered many difficulties. The streets and avenues were resurveyed, graded, and paved, and the parks and boulevards laid out. One of his ambitions was to turn every available foot of space into recreation resorts for the public, and especially for the children. During his term of office the water-works system was entirely reconstructed and the mains extended. Perhaps the most notable work of the City Engineer's Department in this period was the construction of the City Hall, which was built by day labor under the personal supervision of Colonel Cutshaw and his assistants.

Colonel Cutshaw held membership in the Royal Arcanum, the Virginia Historical Society, and the Southern Historical Society. For many years he was President of the Alumni of the Virginia Military Institute, and an active member and patron of the Richmond Young Men's Christian Association.

He was married to Mrs. E. S. Norfleet, his first wife, in December, 1876. She died two months later. In January, 1890, he married Miss M. W. Morton, of Richmond, who died in December of the same year. He left no children.

Colonel Cutshaw's policy had always been a comprehensive system of permanent improvement, rather than any temporary provision, and the whole sewerage system built in Richmond during the past thirty years is the result of his scientific study. He was known as a man of iron will, of indomitable perseverance, and of the highest integrity. He was stern, and unbending, and required implicit obedience and the best that was in his assistants, yet he was always considerate for the unavoidable shortcomings of others, and stood with unflinching constancy by those who were true and faithful.

Colonel Cutshaw lived with Mrs. Calvin Whitely, Jr., his niece, who regarded him almost as her father. He had been ill for several weeks, and his long and eventful life came to a peaceful end on December 19th, 1907.

He was elected a Member of the American Society of Civil Engineers on March 4th, 1891.

CHARLES DAVIS, M. Am. Soc. C. E.*

Died February 21st, 1907.

Charles Davis was born in Bridgetown, Bucks County, Ohio, on July 11th, 1837. His mother died when he was eleven years old, and he left home to live on his uncle's farm. He was educated in the county schools and Jefferson College. In 1861, while in his junior year at college, he enlisted in the Army and served during the Civil War.

After his discharge from the Army he entered an engineer corps making surveys in Lawrence County, Pa., and later accepted a position on a corps surveying for the Western Pennsylvania Railroad.

In 1867 Mr. Davis was elected City Engineer of Allegheny, which position he filled for about eight years. During his term the Allegheny parks were laid out, and a sewerage system was put in. He had the general supervision of the Point Bridge.

In 1878 he made the preliminary surveys for the Pittsburg and Lake Erie Railroad, from Pittsburg to Youngstown, Ohio. He also made surveys for other branches of this road to Connellsville, Pa. In the erection of the buildings of the Pittsburg Bessemer Steel Company at Homestead, in 1880, he was Superintending Engineer, and, subsequently, was Engineer for the Monongahela Bridge Company. In 1881 he was elected County Engineer of Allegheny County, Pa. In conjunction with Mr. H. H. Richardson, Architect for the present Court House, he helped to supervise the erection of that building. He held the position of County Engineer for twenty-six years.

In 1868 Mr. Davis was married to Miss Annie V. Cooper, daughter of James Cooper. She died in 1881. They had five children, of whom three survive him: Norman Cooper Davis, Charles W. Davis, and Mrs. Thomas Leggate.

Mr. Davis died, after a brief illness, at his home in Edgeworth, of pleurisy, complicated with other ailments. He had been suffering for some weeks from a severe cold, but his associates did not suspect that his illness was serious.

Mr. Davis was appointed by the soldiers of Allegheny County as a member of the Committee of Ten for the erection of the Allegheny County Memorial. He was active in the work of this committee, and was present at the meeting of the County Commissioners when the selection of the plan, from the ten designs submitted, was made.

He was a member of the Abe Patterson Post, No. 88, of the Grand Army of the Republic; of Encampment No. 1, Union Veteran Legion; of McKinley Lodge, No. 318, F. and A. M.; Allegheny Chapter of the Royal Arch Masons; of Pennsylvania Commandery and Council. He was a Charter Member and a Past-President of the Engineers' Society of Western Pennsylvania, and Treasurer of the Academy of Science and Art, of Pittsburg.

---

* Memoir prepared by the Secretary from papers on file at the Society House.

Mr. Davis was elected a Member of the American Society of Civil Engineers on September 15th, 1869.

IRVING TUPPER FARNHAM, M. Am. Soc. C. E.*

Died September 19th, 1908.

Irving Tupper Farnham was born in Deposit, Delaware County, N. Y., on August 21st, 1869. His parents were Charles and Julia (Tupper) Farnham. After a preparatory course at Deposit Academy, he entered the College of Civil Engineering of Cornell University, in 1888, and was graduated in 1892 with the degree of Civil Engineer. He was esteemed highly by his professors, and held the position of Librarian during his last two years in college.

His first engagement after graduation was as a Draftsman with the Elmira Bridge Works. In June, 1892, he entered the office of the late Albert F. Noyes, M. Am. Soc. C. E., City Engineer of Newton, Mass., where he obtained experience in a variety of municipal work, first as Instrumentman on the Cheese Cake Brook drainage improvement, then on surveys for the assessors' block system, and then on the Hammond Pond drainage survey for the Board of Health. In 1894 he took charge of the surveys and construction of the first and second sections of the Newton Boulevard, as Division Engineer, having a field office at Chestnut Hill.

On the completion of this work he was put in charge of the Washington Street widening and the abolition of grade crossings on the north side of the city. In 1898 he conducted the surveys for the South Meadow Brook improvement and made preliminary studies for the abolition of grade crossings on the south side of the city.

In February, 1899, Mr. Farnham was appointed Principal Assistant Engineer of the Massachusetts Highway Commission, which position he filled satisfactorily for a little more than a year.

In April, 1900, after the resignation of Henry D. Woods, M. Am. Soc. C. E., as City Engineer of Newton, Mr. Farnham was appointed his successor. He held this position until his death, on September 19th, 1908.

The following are some of the most important works carried out under his direction: In 1900 the extension of the main sewers along the banks of the Charles River toward Newton Upper Falls, and in

---

* Memoir prepared by the Secretary from information on file at the House of the Society, and from a memoir published by the Boston Society of Civil Engineers.

1901 a further extension under the Charles River at Echo Bridge in tunnel to Elliot Street. During that year plans were made for a second section of the covered reservoir on Waban Hill, on which work was commenced but not finished until the following year. In 1902 further sewer extensions were made toward Newton Highlands and Chestnut Hill. Some of these and former sewer extensions involved tunneling under the Cochituate and Sudbury Aqueducts of the Metropolitan Water-Works, and required the greatest care. In 1902, in accordance with an agreement with the Boston and Worcester Railway Company, that company began the widening of about 3 miles of Boylston Street, the City of Newton putting in the drains and inlet basins by day work, all under Mr. Farnham's direction. A small auxiliary pumping plant, for a sewer district at Newton Upper Falls which was below the level of the main sewer, was also designed and built by him. In 1903 the work of abolishing the grade crossings of the Boston and Albany Railroad on the south side of the city was commenced, all the changes in the streets and drains being undertaken by the city. In this work the proper drainage of the depressed tracks made it necessary to lower long stretches of brooks and drains and also make some changes in the sewers. A new concrete bridge over the Charles River at Newton Lower Falls, replacing the Old Red Bridge to Weston, was designed and constructed by Mr. Farnham in 1906.

He was always a student, and the details of all work undertaken in his office received his conscientious and painstaking attention. He was always pleasant with his associates and interested in their welfare.

Mr. Farnham was a Member of the Boston Society of Civil Engineers, and deeply interested in its work. He was a Director of that Society, Clerk of the Sanitary Section, and, at the time of his death, was Chairman of the Committee on Run-off of that section. He spent much time in the study of the question of run-off from sewered areas.

He was also a member of the New England Water Works Association, and of the Massachusetts Highway Association, of which he was President in 1904. The following quotation from the resolutions passed by that Association shows the esteem in which he was generally held:

"A man of character above reproach, an official of most devoted and thorough attention to every detail of his duties, a professional man whose grasp of difficult questions was sure to yield a convincing argument for or against the proposition involved, and whose courage never permitted him to lower the standard he had raised as a governing principle in his work, he had achieved an enviable position as a competent, safe and practical engineer, and there seemed no bar to greater success in his career.

"Too close application resulted in bodily affliction and breaking under the strain, and (we quote the language of his pastor at the funeral) 'sudden darkness came upon his mind, and in that moment of darkness, knowing nothing, he died.'

"His birth, school and college days, as a preparation for his future, and the time of his death are of your official records, and we add now a tribute to his memory, as of a man worthy to be followed in qualities which make for high purpose, purity of life, perseverance under difficulties, and an abiding trust in the Eternal Wisdom, which made and controls the earthly existence and the destinies of men."

Mr. Farnham was a member of the Congregational Church in West Newton, and much interested in its Sunday-school work. He was married on March 27th, 1892, to Miss Jennie A. Carroll. His wife and four children survive him.

He was elected a Member of the American Society of Civil Engineers on May 1st, 1907.

DANIEL FARRAND HENRY, M. Am. Soc. C. E.*

Died May 13th, 1907.

Daniel Farrand Henry was born in Detroit, Mich., on May 27th, 1833. He was the only child of Dr. Stephen Chambers Henry and his second wife, Charlotte (Farrand) Henry. His father was a native of Pennsylvania, who, after his graduation from the University of Pennsylvania, in 1809, moved to Detroit where he began the practice of medicine. He served as an Army Surgeon during the War of 1812, being taken prisoner at the surrender of Detroit by General Hull. He was also active in local and State affairs. His mother was a daughter of Daniel Farrand, one of the Judges of the Supreme Court of the State of Vermont.

On his father's side, Mr. Henry was descended from Robert Henry who, with his family, settled in Chester County, Pennsylvania, in 1722. His great-grandfather, William Henry, who had moved to Lancaster, Pa., served as Armorer under Generals Braddock and Forbes in the expeditions against Fort Duquesne. William Henry took an active part in local and State affairs, holding many positions of trust. During the War of the Revolution he was appointed Assistant Commissary General of the United States, and served two terms (1784-1786) as a Member of the Continental Congress. He was a Member of the American Philosophical Society, a Charter Member of the

---

* Memoir prepared by the Secretary from information supplied by Mr. Henry's nephew, William L. Henry, Esq., and from papers on file at the House of the Society.

Society for Promoting Agriculture, and one of the Founders of the Juliana Library Company, of Lancaster, Pa. Mr. Henry's grandfather, John Joseph Henry, served under General Benedict Arnold in the campaign against Quebec, being captured and afterward paroled. In 1793, he was appointed President Judge of the Second Judicial District of Pennsylvania, holding this position until a year previous to his death.

His father died when Mr. Henry was only one year old. As he was a delicate child, he did not attend school, but was taught the primary branches by his mother, who was well qualified for the task. He made such rapid progress under his mother's tuition that he was soon able to read books of a character much above the capacity of boys of his age, and as much of his time was spent indoors, on account of his health, he found his chief pleasure in books.

When he was ten years old, Mr. Henry was sent to Canandaigua Academy, where he remained only a short time. He then attended the old Capitol School, in Detroit, and from there he was sent to school at Newark, Ohio, and then to Canandaigua Academy. When he was sufficiently advanced to begin his higher studies, he attended a scientific school in Providence, R. I., where he made rapid progress, his proficiency in the higher mathematics being phenomenal. He seemed to accomplish by intuition what most people attain only by laborious effort and persistent study.

He was a member of the first class of Sheffield Scientific School of Yale University, and was graduated with distinction in 1853.

Upon his return to Detroit, in 1853, Mr. Henry was appointed to a position in the United States Lake Survey, under Lieutenant W. F. Reynolds, U. S. A., who was then in charge of the Survey of the Northern and Northwestern Lakes for that District. He continued in this work until 1871, holding various important positions, under Lieutenant Reynolds and several of his successors. In 1856, he was chief of a shore party; from 1861 to 1867 he was in charge of the triangulation and the measurement of primary bases; from 1868 to 1871 he superintended the measurement of the outflow of the Lakes; and for about six years he was also in charge of the Meteorological Department.

During the seventeen years of his connection with the Government Survey of the Northern and Northwestern Lakes, Mr. Henry accumulated valuable information as a result of his untiring observations and experiments, much of which may be found in scientific publications. His observations on the overflow of the Lakes and on the sudden rise and fall of their levels, are regarded as the highest authority on the subject, and have been the cause of much discussion. It was in connection with these observations that he invented the telegraphic current meter which has come into general use for velocity measurements and for which, together with the flexible inlet pipe, invented for use at the Detroit Water-Works, he was granted a medal at the Centennial Exposition in 1876. His book on the "Flow of Water in Rivers and Canals" has received the highest praise.

Mr. Henry took an active interest in affairs outside of his work. Being an enthusiast about physical exercise, he was one of the organizers of the Detroit Gymnasium in 1856. He was also a member of the Young Men's Society, before which he frequently delivered scientific lectures. He was also one of the organizers of the Detroit Scientific Association, serving as one of its Curators for several years.

In 1871, Mr. Henry became a partner in the Chicago Seed Company, remaining in the seed business until 1873, first in Chicago and afterward in Detroit. His company was burned out in the great Chicago fire on October 8th and 9th, 1871, by which Mr. Henry lost, besides his business, a large portion of his library, much of which could never be replaced.

In 1872 he was appointed Chief Engineer of the Detroit Water-Works, continuing in this position until 1878. During this time the present pumping works above the city were constructed, and it was for use at this plant that Mr. Henry invented the flexible inlet pipe already mentioned.

In 1880, he went to the Upper Peninsula of Michigan as Consulting Engineer for the Detroit, Mackinac, and Marquette Railroad. His first work was in connection with observations on the ice in the Straits of Mackinac. He also made a canoe trip from Lake Superior to Lake Michigan in order to examine the drainage of the swamp through which the railroad was to pass.

During his residence on the Upper Peninsula Mr. Henry laid out nine villages and stations for the Peninsular Land Company; he was engaged for some time at Sault Ste. Marie, in the employ of a water-power company; and designed a new system of water-works for the city; he was the Architect of the present Chippewa County Court House; and for some years was engaged in private practice.

About 1890 Mr. Henry returned to Detroit, where he was in private practice as a Consulting Engineer until his death on May 13th, 1907. One of his last works of engineering was as Projector and Chief Engineer of the St. Clair and Erie Ship Canal, which, however, was never built.

Mr. Henry had never married. He had taken all the Masonic degrees, and was a Member of the Veteran Corps of the Detroit Light Guards, which he had joined in the later Fifties.

Mr. Henry was elected a Member of the American Society of Civil Engineers on July 7th, 1875.

GEORGE ANTHONY LEDERLE, M. Am. Soc. C. E.*

Died March 27th, 1905.

George Anthony Lederle was born, of German parentage, in Detroit, Mich., on September 4th, 1858. His father was, for many years, in the United States Lighthouse Service, engaged in constructing lighthouses.

Mr. Lederle entered the University of Michigan in 1877, and was graduated in 1881 as a Civil Engineer. After leaving the University, he was engaged for several years with the late George S. Morison, Past-President, Am. Soc. C. E., on bridge construction. During this time he was in charge of the construction of the Union Pacific Bridge across the Missouri River, at Omaha, Nebr., the bridge across the Willamette at Portland, Ore., and the viaduct at Morent Mountain.

George B. Christie and Jesse Lowe, Members, Am. Soc. C. E., having organized the firm of Christie and Lowe, to engage in general contracting, invited Mr. Lederle to join the firm. After considering the proposition for a year, he decided to become a partner, which he did in 1892. During his connection with this firm, Mr. Lederle had personal charge of some of its most important contracts. When the contract to build the jetties at the Southwest Pass was awarded to this firm in 1903, he went to New Orleans, La., and took charge of the actual construction. He was engaged on this work when he died, after a short illness, on March 27th, 1905.

Mr. Lederle was not married. He was a Member of the Western Society of Civil Engineers and of the Louisiana Engineering Society. He was also a Member of the Delta Kappa Epsilon Fraternity.

He was known all over the United States as a civil engineer of renown, and in an obituary notice, dictated by his partners and published in *The Daily Picayune* of New Orleans, La., it is stated that:

> "Mr. Lederle was ever of a quiet demeanor. He was a man who had little to say, but who meant what he said. Of strong convictions, of strong likes and dislikes, he was ever kindly and gentle. Those who knew him, knew him only to love him, and he had friends by the hundreds in all parts of the country. The two surviving members of the firm who worked with him through so many years, particularly feel the loss, for few knew him better or loved him more than these two."

Mr. Lederle was elected a Junior of the American Society of Civil Engineers on May 2d, 1883, and a Member on October 6th, 1886.

---

* Memoir prepared by the Secretary from papers on file at the House of the Society.

JOHN EGBERT McCURDY, M. Am. Soc. C. E.*

Died December 14th, 1908.

John Egbert McCurdy was born near Quitman, Miss., on June 10th, 1861. His parents moved to Lawrence, Kans., in 1864. As he was a very delicate child, his parents sent him to Boston, in 1866, where he was placed under the care of a specialist; at the end of two years, however, he returned to his home with his health but little improved.

He was educated at the Lawrence High School and Kansas State University where he spent three years. During his college years he was engaged in various land and town surveys.

On leaving college he served for two months as Transitman on location surveys for the Carbondale Extension of the Kansas Pacific Railway, and then as Topographer, Office Engineer, and Assistant Engineer, on the Kansas City, Springfield, and Memphis Railway, first on surveys, and finally on construction. For a few months in 1883 he was engaged in private practice in El Paso, Tex. He then went to Mexico as Topographer on surveys for the Mexican Central Railway. From 1884 to 1887 he served in the Operating Department of the latter railway, and was afterward appointed Division Engineer on the Guadalajara Extension.

From July, 1888, to November, 1890, Mr. McCurdy was employed as Locating Engineer on the Mexican Southern Railway, then, until June, 1892, as Division Engineer in charge of the construction of the Tomellin Cañon Division, and was then engaged in reconnaissance surveys for that railway until January, 1893.

From January, 1893, to May, 1894, he was in private practice in the City of Mexico, reporting on water-works and railways. During this period he made surveys for the Ferrocarril de Guadalupe to Zacatlan, and, as Manager and Chief Engineer, located the Ferrocarril del Cazadero á Solio, which was partly graded when work was suspended for financial reasons.

In June, 1894, he was appointed Resident Engineer on the Chihuahua Water-Works, for which he conducted the surveys, design, and construction.

Mr. McCurdy was interested in several mines in the States of Chihuahua, Durango, and Oaxaca, and carried out considerable contract work on the construction of buildings, sewers, and irrigation projects. At the time of his death he had just completed the construction of the Oaxaca and Oriental Railway.

---

* Memoir prepared by the Secretary from information supplied by J. W. Miles, M. Am. Soc. C. E., and from papers on file at the House of the Society.

Mr. McCurdy was one of the best known engineers in Mexico, and, in the design and execution of work, was considered a very capable man. His opinions were eagerly sought, both by engineers and contractors, when difficult problems were encountered.

He was a Member of the American and Jockey Clubs, of the City of Mexico.

He died in the American Hospital, in the City of Mexico, on December 14th, 1908, from the effects of a surgical operation. He is survived by two sisters, Mrs. Mais, of Texas, and Miss F. Eleanor McCurdy, of Lawrence, Kans.

Mr. McCurdy was elected a Member of the American Society of Civil Engineers on April 1st, 1896.

WILLIAM ANSON PEARSON, Jr., M. Am. Soc. C. E.*

Died May 26th, 1908.

William Anson Pearson, Jr., son of W. A. and Margaret Pearson, was born on July 29th, 1855, at Athens, Bradford County, Pa., where he received his early education. He was graduated from the High School at Sayre, Pa., in 1870.

He served his apprenticeship as a machinist in the shops of the Delaware, Lackawanna, and Western Railroad, in Scranton, where his exceptional ability soon won him the position of foreman.

He served in the Motive Power and Civil Engineering Departments of the Union Pacific Railroad, in Omaha, Nebr., for three years. In 1879 and 1880 he was Master Mechanic for the Virginia-Trukkey Railroad at Carson City, Nev., and from 1880 to 1884 was Superintendent of Construction on the Comstock Lode, in charge of the connection of all the mines with the Sutro Tunnel.

In 1884 he moved to Boston, Mass., and practised as a Consulting Engineer for two years. Then for a year he was Superintendent of the Marine Engine Department of the Dickson Manufacturing Company, at Scranton, Pa. From 1887 to 1893 he was with the Boies Steel Wheel Company, at Scranton, first in charge of design and construction, and later as Manager of the plant.

In 1893 Mr. Pearson became associated with the General Electric Company, with headquarters at Schenectady, N. Y., and from that time until his death was Chief Engineer, in charge of the design and construction of all buildings, steam and water mains, railroads, sewers, yards, etc. The buildings at the various plants of this company bear witness to his ability.

---

*Memoir prepared by the Secretary from information furnished by L. C. Reynolds, Assoc. M. Am. Soc. C. E., and from papers on file at the House of the Society.

Mr. Pearson was greatly beloved by his associates because of his thorough honesty in everything. In the latter part of his life, it was his aim to help young men in their upward course in the world. He was very eager and ready to assist wherever he could, and many enjoyed his help and inspiration.

Mr. Pearson was an active member of the Masonic Order, and at the time of his death was a member of St. George's Lodge, No. 6, F. and A. M.; St. George's Chapter, No. 157, R. A. M., and St. George's Commandery, No. 37, Knights Templars. He was also a Member of the American Society of Mechanical Engineers, a Member of the Royal Arcanum, and an active worker and officer of the First Presbyterian Church of Schenectady, N. Y.

In 1885 he married Miss Mary Burns, who died a year later, and in 1888 he married Miss Helen Franklin, who died in 1896. He is survived by one sister, Mrs. Lucy A. Cordeaux, and her daughter, Miss Helen Cordeaux, of Schenectady, N. Y.

Mr. Pearson's health failed continuously for about a year previous to his death, but his enjoyment of his work was such that it was with difficulty that he was persuaded to leave it. However, he decided to take a trip to Virginia and possibly abroad, with the expectation of then resuming his work, but he had just started upon his journey when he was taken seriously ill and immediately returned to his home in Schenectady. He had been home but a few hours when he died.

Mr. Pearson was elected a Member of the American Society of Civil Engineers on September 6th, 1905.

ARCHIBALD ALEXANDER SPROUL, Jr., M. Am. Soc. C. E.*

Died April 26th, 1910.

Archibald Alexander Sproul, Jr., a son of Archibald Alexander Sproul, was born on January 10th, 1868, near Middlebrook, Augusta County, Va., where he resided, until he reached his majority, at the old family home first settled by the Sprouls in 1745. His parents were of the Scotch-Irish stock of the region, and Presbyterians.

The son, like the father, was educated at Washington College, Lexington, Va. (now the Washington and Lee University), and was graduated in June, 1890, when he took up his profession as Civil Engineer. He was one of the most popular men in the University both with his fellow-students and in the society of the town.

Immediately on his graduation Professor D. C. Humphreys, his Instructor, who was also Engineer for the Grottoes Company and engaged in laying out a town to be known as Shendun, organized what he called "The College Party," composed entirely of college students, and put Mr. Sproul in charge. His work in this position was more than satisfactory, and was considered by Professor Humphreys to be the best he had ever known to be done by a boy, fresh from college and without any previous practical experience.

---

* Memoir prepared by David C. Humphreys and Robert Ridgway, Members, Am. Soc. C. E.

For a short time after this Mr. Sproul was engaged in other lines than Civil Engineering, having charge, for some time, of a match factory in the region of his home.

The Official Survey of Roanoke, Va., having been ordered by the Court, was undertaken in 1891 under the direction of Mr. George P. Wood and the City Engineer, Mr. William M. Dunlap. Early in the following year Mr. Sproul sought and obtained a position with the Survey, and remained with it until June, 1893, when he resigned to take charge, as Assistant Engineer, of one of the parties organized for the Topographical Survey of the City of Baltimore, of which General Henry T. Douglas was Chief Engineer. He left on October 31st, 1895, on the practical completion of the field work of this important and well-known survey. Both the surveys mentioned were made by precise methods practically applied, and Mr. Sproul's assistance in obtaining the very satisfactory results was much appreciated by his superior, Mr. Wood, who often refers to him in the warmest terms.

In March, 1896, he accepted a position as Assistant Engineer in the Bureau of Highways, Borough of the Bronx, New York City, which he retained for more than four years. This covered a period of great development in the highway system of the Borough, and he was closely identified with its work of construction.

In June, 1900, Mr. Sproul entered the service of the Rapid Transit Railroad Commission, in New York City, and was placed in responsible charge, as Assistant Engineer, of the heavy section of subway construction known as "6B," on Broadway, between 82d and 104th Streets, remaining there for more than five years, until the work was completed and the road in successful operation. This was one of the most important sections of construction on the line of the Manhattan-Bronx subway, and included the complicated details of the junction of the Broadway and Lenox Avenue branches above the 96th Street Station. The estimated cost of its construction was about $6 000 000.

The Board of Water Supply, provided for by an act of the Legislature in 1905, for the purpose of securing an additional supply of water for New York City, was appointed in June, 1905. In September of that year Mr. Sproul took a position as Assistant Engineer with that Board, and when the organization of the Engineering Bureau was permanently effected, was, on April 15th, 1907, made Division Engineer of the Peekskill Division of the Catskill Aqueduct, which is designed for a capacity of 500 000 000 gal. daily. This Division, 13 miles long, is on the east side of the Hudson River, and extends from the vicinity of the Village of Cold Spring south to the Croton watershed, traversing the rough and historic country of the Hudson Highlands. In addition to about 8 miles of open-cut work, it includes three tunnels, one more than two miles long, as well as three steel pipe siphons, aggregating about two miles in length. The line was located under Mr. Sproul's personal direction, and was so intelligently and vigorously prosecuted that in a little more than a year after he took charge the difficult work was accomplished and the entire division, except the three siphons, was ready to be placed under construction. In the spring of 1907 a contract of an estimated value of more than $4 100 000 was let for the work, exclusive of the siphons, Mr. Sproul remaining in charge of the construction until May 9th, 1909, when he resigned to become Managing Engineer for the Receivers of the original contractor, who were then carrying on the work. This position he occupied until he resigned on March 1st, 1910.

While on a visit to his old home in Virginia during the following month, he had an attack of pneumonia, and, after a short illness, died on April 26th, 1910. His widow, who was Miss Mary I. Cotton, of New York City, to whom he was married on October 12th, 1897, and a son nine years of age, survive him.

A man of broad views and deep convictions, of flawless rectitude and high attainments in his professional work, Mr. Sproul was clear in his perception of his duties, and fearless in carrying out without prejudice what he believed was right. He was discreet in his friendships, and having selected his friends, no one was more loyal to them than he. More than most men he was beloved and respected for his many amiable and sterling qualities by those who had the privilege of knowing him well, and the profession is poorer by reason of his death.

Mr. Sproul was elected a Member of the American Society of Civil Engineers on May 1st, 1907.

RICHARD FENWICK THORP, M. Am. Soc. C. E.*

DIED JULY 28TH, 1908.

Richard Fenwick Thorp, the second son of the Reverend William Tudor Thorp, of Charlton Hall, Northumberland, England, was born on September 2d, 1868. His education was begun at Malvern College and continued at Richmond, Yorkshire. In 1887 he entered the Royal Indian Engineering College, at Cooper's Hill.

---

* Memoir prepared by the Secretary from information furnished by Mr. Thorp's family.

In 1890 Mr. Thorp entered the service of the Great Western Railway, first as unpaid assistant, later as full assistant, and then as Executive Engineer. During his seven years with this company, he made bridgework his special study. At the time he joined, the main line was being double-tracked, and, after assisting in the widening of Maidenhead Bridge (having two brick arches, each of 127 ft. span), Moulsford and Gatehampton Bridges (each having four brick arches, of 70 and 80 ft., respectively), he was put in charge of a 6-mile section which included the Kennet Bridge (a 60-ft. brick arch) and several large steel overbridges. In March, 1892, he was appointed on the staff of Mr. L. Trench, Chief Engineer, to inspect and report on the old iron and timber bridges on the whole of the company's system, and to design new superstructures where necessary. Some of these old bridges were the stone and timber viaducts erected across the Cornish valleys by Brunel, and, though in most cases, they were perfectly sound, they were not suitable for the much greater traffic and heavier loads of modern times.

When this work was finished Mr. Thorp was put in charge of various new works for the company, and for two years was Executive Engineer in charge of the widening of the Berks and Hants Section, between Hungerford and Devizes (23 miles), which work included the designing of all necessary bridges.

In 1897 Mr. Thorp became Chief Engineer of the Kanan Devan Hills Products Company, in South India, and took up his duties there in March, 1898. The company had obtained from the Travancore Government, a concession of 200 sq. miles of land in the hills of North Travancore, known as the High Range, for the purpose of growing tea, coffee, cinchona, and other produce. The country, however, was almost inaccessible, communication being restricted to a few bridle paths. All materials and provisions were carried up from the low country on the heads of coolies or on pack bullocks and donkeys, wheeled vehicles being unknown in the hills.

The first works undertaken were a wire ropeway from the foot of the hills to the top, and, from the top of this ropeway to Munaar, the center of the planting district, 20 miles of cart road on which was laid a Ewing one-rail tramway. The ropeway had a rise of 4 200 ft., was 2½ miles long, and was operated by electricity, generated by water-power at the bottom.

Then 10 miles of cart road were made (for the Madras Government) from the foot of the ropeway, to connect with the Government roads on the plains; and 38 miles of cart road were built from Munaar, to connect with the Government roads on the other, or northern, side of the concession (for the Travancore Government).

All these works were carried out with native labor, under Mr. Thorp's personal supervision, with one or two European assistants.

All the necessary bridges were designed by him. The work of road making in these hills was by no means easy, on account of the rough and steep nature of the ground, the difficulty and expense of carrying up large pieces of ironwork, and, not least, the terrible havoc wrought by the Southwest Monsoon on anything but firmly established work.

By the time the roads were finished and other smaller works (such as water-power schemes for the various new factories of the district) were completed, the tea was grown up and coming into full bearing, and, although Mr. Thorp's original 5-year appointment was ended, the company asked him to remain and complete an electrical power scheme to facilitate the increasing work in as many factories as possible.

Near Munaar there is a large waterfall known as the Pullivasal Falls, giving a head of 380 ft. and a minimum supply of 2 000 ft. per min. A watercourse and head tank were built along the face of the rock at the head of the falls, and from there two pipes were conducted to the power-house in the jungle below, there operating two turbines coupled to two 100-kw. alternating-current generators. The current is transmitted, at 2 200 volts, over the hills in different directions to five factories at distances varying from 2 to 4 miles. There was great difficulty in erecting machinery in such steep and deeply wooded country. For some of the pieces, the bridle roads had to be widened, and their weight, considered only from the standard of human labor, was tremendous. It was completed, however, and worked successfully from the first day the power was applied.

In August, 1906, Mr. Thorp returned to England, and later entered into partnership with Mr. B. H. Thwaite. Soon after this, however, his fatal illness began, and, though he fought it with untiring patience and courage, he died in London on July 28th, 1908. He was buried at Alnwick, Northumberland, among his own people.

Mr. Thorp held strong views on the necessity for professional education and continual study, as well as practical experience, in the qualification of a Civil Engineer. He was one who, at all times, upheld the honor of his profession, and was held in high esteem, by his colleagues, for his thorough professional knowledge; by his subordinates for his just dealing; and by all, for his unimpeachable integrity.

He was made a Member of the Institution of Civil Engineers on March 28th, 1905, having passed through the preliminary grades of Student and Associate Member, and in 1907 was awarded the Crampton Prize for his paper on the "Munaar Valley Electrical Power Scheme."

Mr. Thorp was elected an Associate Member of the American Society of Civil Engineers on October 5th, 1904, and a Member on March 5th, 1907.

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XXXVI—No. 9

AMERICAN
SOCIETY OF
CIVIL
ENGINEERS
FOUNDED
1852

November, 1910

ublished at the House of the Society, 220 West Fifty-seventh Street, New York,
the Fourth Wednesday of each Month, except June and July.

Copyrighted 1910, by the American Society of Civil Engineers.
tered as Second-Class Matter at the New York City Post Office, December 15th, 1906.
Subscription, $8 per annum.

LIBRARY
NORTH DAKOTA AGRICULTURAL
COLLEGE AND EXPERIMENT STATION

No. 24268

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XXXVI—No. 9
NOVEMBER, 1910

Edited by the Secretary, under the direction of the Committee on Publications.

Reprints from this publication, which is copyrighted, may be made on condition that the full title of Paper, name of Author, page reference, and date of presentation to the Society, are given.

CONTENTS

Society Affairs.........................Pages 487 to 528.
Papers and Discussions ....Pages 1319 to 1558.

NEW YORK 1910.

Entered according to Act of Congress, in the year 1910, by the American Society of Civil Engineers, in the office of the Librarian of Congress, at Washington.

American Society of Civil Engineers

OFFICERS FOR 1910

President, JOHN A. BENSEL

Vice-Presidents

Term expires January, 1911:
GEORGE H. PEGRAM
EMIL SWENSSON

Term expires January, 1912:
JOHN T. FANNING
HUNTER McDONALD

Secretary, CHARLES WARREN HUNT

Treasurer, JOSEPH M. KNAP

Directors

Term expires January, 1911:
CHARLES L. HARRISON
GEORGE W. KITTREDGE
DEXTER BRACKETT
HORACE ANDREWS
GARDNER S. WILLIAMS
CHARLES S. CHURCHILL

Term expires January, 1912:
FRANCIS LEE STUART
SAMUEL C. THOMPSON
WILLIAM G. WILKINS
ARTHUR N. TALBOT
WILLIAM M. GARDNER
HORACE A. SUMNER

Term expires January, 1913:
WILLIAM E. BELKNAP
HORACE LOOMIS
GEORGE A. KIMBALL
PERCIVAL ROBERTS, JR.
CHARLES F. LOWETH
ARTHUR DEWINT FOOTE

Assistant Secretary, T. J. McMINN

Standing Committees

(THE PRESIDENT OF THE SOCIETY IS *ex-officio* MEMBER OF ALL COMMITTEES)

On Finance:
GEORGE H. PEGRAM
CHARLES S. CHURCHILL
GEORGE A. KIMBALL
HORACE LOOMIS
WILLIAM G. WILKINS

On Publications:
C. L. HARRISON
HORACE ANDREWS
WILLIAM E. BELKNAP
FRANCIS LEE STUART
EMIL SWENSSON

On Library:
GEORGE W. KITTREDGE
DEXTER BRACKETT
JOHN T. FANNING
HUNTER McDONALD
CHAS. WARREN HUNT

Special Committees

ON UNIFORM TESTS OF CEMENT: George S. Webster, Richard L. Humphrey, George F. Swain, Alfred Noble, Louis C. Sabin, S. B. Newberry, Clifford Richardson, W. B. W. Howe, F. H. Lewis.

ON CONCRETE AND REINFORCED CONCRETE: C. C. Schneider, J. E. Greiner, W. K. Hatt, Olaf Hoff, Richard L. Humphrey, Robert W. Lesley, Emil Swensson, A. N. Talbot, Joseph R. Worcester.

ON ENGINEERING EDUCATION: Desmond FitzGerald, Benjamin M. Harrod, Onward Bates, D. W. Mead, Charles Hansel.

ON STEEL COLUMNS AND STRUTS: Austin L. Bowman, Alfred P. Boller, Emil Gerber, Charles F. Loweth, Ralph Modjeski, Frank C. Osborn, George H. Pegram, Lewis D. Rights, George F. Swain, Emil Swensson, Joseph R. Worcester.

ON BITUMINOUS MATERIALS FOR ROAD CONSTRUCTION: W. W. Crosby, A. W. Dean, H. K. Bishop, A. H. Blanchard.

◆

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

HOUSE OF THE SOCIETY—220 WEST FIFTY-SEVENTH STREET, NEW YORK.

TELEPHONE NUMBER.................5913 Columbus.
CABLE ADDRESS..................."Ceas, New York."

Vol. XXXVI. NOVEMBER, 1910. No. 9.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

SOCIETY AFFAIRS

CONTENTS

Minutes of Meetings: PAGE
  Of the Society, October 19th and November 2d, 1910 487
  Of the Board of Direction, November 1st, 1910 490
Announcements:
  Hours during which the Society House is open 491
  Future Meetings 491
  Annual Meeting 491
  Special Meetings for Topical Discussion 491
  Proposed Amendment to the Constitution 492
  Searches in the Library 493
  Papers and Discussions 493
  Subscription Price to the Publications of the Society 494
  Local Associations of Members of the American Society of Civil Engineers 494
  Privileges of Engineering Societies Extended to Members 496
Accessions to the Library:
  Donations 498
  By purchase 502
Membership (Additions, Changes of Address, Deaths) 503
Recent Engineering Articles of Interest 511

MINUTES OF MEETINGS

OF THE SOCIETY

October 19th, 1910.—The meeting was called to order at 8.30 P. M.; President John A. Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, 124 members and 14 guests.

A paper by W. F. Strouse, M. Am. Soc. C. E., entitled "The Reconstruction of the Passenger Terminals at Washington, D. C.," was presented by title.

T. Kennard Thomson, M. Am. Soc. C. E., presented a paper on "Rust, as Shown in the Removal of a Seventeen-Story Building," and the subject was discussed by Messrs. A. W. Carpenter, F. Lavis, S. M. Purdy, R. A. MacGregor, J. B. French, T. T. Allard, F. W. Gardiner, and the author.

The Secretary announced the following deaths:

James Archbald, elected Member May 15th, 1872; died October 5th, 1910.

Edwin Peleg Dawley, elected Member April 1st, 1885; died October 7th, 1910.

Adjourned.

November 2d, 1910.—The meeting was called to order at 8.30 p. m.; Director Gardner S. Williams in the chair; Chas. Warren Hunt, Secretary; and present, also, 134 members and 26 guests.

The minutes of the meetings of September 21st and October 5th, 1910, were approved as printed in *Proceedings* for October, 1910.

A paper by C. R. Grimm, M. Am. Soc C. E., entitled "The Arch Principle in Engineering and Esthetic Aspects, and Its Application to Long Spans," was presented by title.

A written communication on the paper by Max M. Miller, Assoc. M. Am. Soc. C. E., was presented by the Secretary, and the subject was discussed orally by Leon S. Moisseiff, M. Am. Soc. C. E.

The Secretary announced the election on November 1st, 1910, of the following candidates:

As Members.

Herman Renner Blickle, Pittsburg, Pa.
William Henry Burger, Evanston, Ill.
Charles E. Conover, New York City.
John Henry Frederickson, Denver, Colo.
James Postell Jervey, Gatun, Canal Zone, Panama.
Herbert Sawyer Kimball, Boston, Mass.
John Mason Robinson, Manãos, Brazil.

As Associate Members.

William Valorus Alford, Garrettsville, Ohio.
John Henry Ayres, Manila, Philippine Islands.
Ernest Bateman Black, Kansas City, Mo.
Luther Harold Burt, White Plains, N. Y.
Charles Longford Cadle, Rochester, N. Y.
Phillip Caro, Sydney, New South Wales, Australia.
Stewart Garfield Collins, Duluth, Minn.
Edmund Henry Doyle, Miami, Okla.
George Dunglinson, Jr., Bluefield, W. Va.
Warren Egbert, Groveland, Cal.
Walter Herbert Fulweiler, Moylan, Pa.
Harry Woy Gray, Ames, Iowa.
William Scott Hanley, Chicago, Ill.
Jacob Duncan Jaques, Woodbury, N. J.
Joseph Navarre McLoughlin, Pocatello, Idaho.

GEORGE ELDRIDGE MORRISON, East Las Vegas, N. Mex.
CHARLES SOUNDERS PAGET, Canton, China.
PHILIP HENRY PARTHESIUS, Troy, N. Y.
MARTIN COLLINS POLK, Chico, Cal.
HARRY ADAM RAIDER, Canton, China.
AUGUSTUS WEBSTER ROGERS, London, England.
HARRY SPENCER SLOCUM, New York City.
HERMAN STABLER, Washington, D. C.
WILLIAM FIELD TENNEY, Watertown, N. Y.
GEORGE WILLIS WADE, San Francisco, Cal.

AS ASSOCIATE.

CHARLES MERIWETHER CHRISTIAN, Poughkeepsie, N. Y.

AS JUNIORS.

LEON BARTON ALEXANDER, Detroit, Mich.
JOHN CLEAVELAND BEEBE, Helena, Mont.
ALEXANDER FLETCHER BOIG, Beaver Falls, Pa.
HOWARD FRANKLIN BRONSON, Rochester, N. Y.
FREDERICK WILLIAM CASPARI, Baltimore, Md.
JAMES BLAINE THOMAS COLMAN, Iloilo, Panay, P. I.
DAVID METHENY DODDS, Denver, Colo.
BENJAMIN JAY GARNETT, Spokane, Wash.
VICTOR HUGO GARVEY, Sumner, Wash.
GORDON MERCER GILKISON, Provo, Utah.
HAROLD EARLE GILL, Peekskill, N. Y.
MANTON HANNAH, Paris, Tex.
ALFRED BRACKENRIDGE HEISER, Brooklyn, N. Y.
WILLIAM JOSEPH HEISER, Brooklyn, N. Y.
JOHN TAYLOR HENDERSON, Arco, Idaho.
ROLAND ELLIS HUTCHINS, Philadelphia, Pa.
HARRY BERNARD O'NEIL, Providence, R. I.
LYFORD ROME, Brooklyn, N. Y.
GEORGE PETER SEARIGHT, New York City.
WILLIAM CLAUDE SWETT, Pocatello, Idaho.
RAFAEL JOAQUIN TORRALBAS, Havana, Cuba.
JOSEPH UPTON, Flushing, N. Y.
DWIGHT NELSON WETHERELL, Carthage, Mo.

The Secretary announced the transfer on November 1st, 1910, of the following candidates:

FROM ASSOCIATE MEMBER TO MEMBER.

WILLIAM GREENE ATWOOD, Indianapolis, Ind.
JOSEPH CARROLL BARR, Joplin, Mo.
JOHN BLODGETT, Martins Ferry, Ohio.

Stephen Pearson Brown, New York City.
Loren Bradley Curtis, Denver, Colo.
Abraham Gideon, Manila, Philippine Islands.
Russell Theodore Hartman, Des Moines, Iowa.
Stephen Ford Holtzman, New York City.
Lindsey Louin Jewel, Pittsburg, Pa.
David Read Lee, Fort Edward, N. Y.
John Gates Peck, Cold Spring, N. Y.
Charles Morton Strahan, Athens, Ga.
Willis Whited, Pittsburg, Pa.
Dethic Hewitt Wood, Chattanooga, Tenn.

From Junior to Associate Member.

Arthur Robert Eitzen, Kansas City, Mo.
John Marvin Peters, St. Louis, Mo.
Robert Isham Randolph, Chicago, Ill.
Patricio Andres Suarez y Cordoves, Havana, Cuba.
Lee Field Whitbeck, Durango, Mexico.

The Secretary announced the following death:

Henry Harding, elected Member May 7th, 1873; died October 23d, 1910.

Adjourned.

OF THE BOARD OF DIRECTION

(Abstract)

November 1st, 1910.—President Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Bates, Belknap, Kimball, Kittredge, Loomis, Pegram, Schneider, Stearns, Swensson, Thompson, and Williams.

Ballots for membership were canvassed, resulting in the election of 7 Members, 25 Associate Members, 1 Associate, and 23 Juniors, and the transfer of 5 Juniors to the grade of Associate Member.

Fourteen Associate Members were transferred to the grade of Member.

Applications were considered and other routine business transacted.

Adjourned.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

December 7th, 1910.—8.30 P. M.—At this meeting two papers will be presented for discussion, as follows: "Bond-Friction-Resistance in Reinforced Concrete," by William Fry Scott, Assoc. M. Am. Soc. C. E.; and "Hydrography as an Aid to the Successful Operation of an Irrigation System," by J. C. Stevens, Assoc. M. Am. Soc. C. E.

Mr. Scott's paper was printed in *Proceedings* for October, 1910, and that by Mr. Stevens appears in this number of *Proceedings*.

December 21st, 1910.—8.30 P. M.—Two papers will be presented for discussion, as follows: "Notes on the Bar Harbors at the Entrances to Coos Bay, and Umpqua and Siuslaw Rivers, Oregon," by Morton L. Tower, M. Am. Soc. C. E.; and "Timber Preservation, Its Development and Present Scope," by Walter Buehler, M. Am. Soc. C. E.

These papers are printed in this number of *Proceedings*.

January 4th, 1911.—8.30 P. M.—A paper entitled "The Valuation of Public Service Corporation Property," by Henry Earle Riggs, M. Am. Soc. C. E., will be presented for discussion.

This paper is printed in this number of *Proceedings*.

ANNUAL MEETING

The Fifty-eighth Annual Meeting will be held at the Society House, on Wednesday and Thursday, January 18th and 19th, 1911. The Business Meeting will be called to order at 10 o'clock on Wednesday morning. The Annual Reports will be presented, officers for the ensuing year elected, members of the Nominating Committee appointed, Reports of Special Committees presented for discussion, a proposed amendment to the Constitution presented for action, and other business transacted.

SPECIAL MEETINGS FOR TOPICAL DISCUSSION

Preliminary notice is hereby given that on Friday and Saturday, January 20th and 21st, 1911 (the days following the close of the Annual Meeting of the Society), three meetings of the Society will be held, the first on the morning of Friday, January 20th, 1911, the second on the afternoon of that day, and the third on the morning of Saturday, January 21st, 1911.

At these meetings the general subject for topical discussion and its subdivisions, which will be taken up separately, are:

"Road Construction and Maintenance."

(1) Preliminary Investigations.

(2) Relative Value of Three Methods of Carrying on Work:
  (*a*) That in which both labor and material are furnished by the contractor.
  (*b*) That in which the material is supplied by the party of the first part, and the labor by the contractor.
  (*c*) That in which both the labor and material are supplied by the party of the first part.

(3) Systems of Maintenance.

(4) The Use of Water, Calcium Chloride, Light Oils, etc., as Dust Palliatives.

(5) Surface Treatment with Tars, Heavy Oils, etc.

(6) The Use of Bituminous Materials by Penetration Methods.

(7) The Use of Bituminous Materials by Mixing Methods.

The discussion on each of the above topics will be presented by an engineer specially selected for that purpose, and such presentation will be limited to ten minutes; the discussion of each of the subsequent speakers will be limited to five-minute talks, in order that every one interested may have an opportunity to give his views, and that the resulting discussion, when edited and collated, under the rules of the Society, for publication, may be a concise summary of present-day practice.

All engineers interested in road building, whether members of the Society or not, are invited to be present and take part in this discussion.

The hours for holding the meetings, names of speakers, etc., will be given in a subsequent notice.

PROPOSED AMENDMENT TO THE CONSTITUTION

The following proposed amendment to the Constitution was received on the first Wednesday in November, 1910, and is herewith brought to the attention of all Corporate Members.

This amendment will be presented to the Annual Meeting, January 18th, 1911, as provided in Section 2 of Article IX of the Constitution, which reads as follows:

"2. Amendments presented to the Secretary on or before the first Wednesday in November shall be sent by letter to the several Corporate Members of the Society at least twenty-five days previous to the Annual Meeting. Such amendments shall be in order for discussion at such Annual Meeting, and may be amended in any manner pertinent to the original amendments by a majority vote of the Annual Meeting, and if so amended shall be voted upon by letter-ballot in form as amended by the Annual Meeting; if not so amended, they shall be voted upon by letter-ballot as submitted. The vote to be counted at the first regular meeting in March."

Amend Article IV, as follows:

Add at the end of Article IV, the following:

"13. Corporate Members and Associates who have reached the age of seventy years, and who have paid dues as such for twenty-five years, shall be exempt from further dues. Corporate Members and Associates who have paid dues as such for thirty-five years shall be exempt from further dues."

The above amendment is signed by the following Corporate Members: Kenneth Allen, A. L. Bowman, F. W. Gardiner, J. A. Knighton, C. D. Pollock, Robert Ridgway, J. Waldo Smith, and Geo. W. Tillson.

This is an advance notice; the Constitution will be complied with by mailing this announcement to all Corporate Members.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendix* to the Annual Report of the Board of Direction for the year ending December 31st, 1906, contains a summary of all searches made to that date.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussion of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings*. The issue of volumes of *Transactions* is dependent on the closing of discussions, and the co-operation of the membership in this matter is essential to the regular issue of each quarterly volume.

---

* *Proceedings*, Vol. XXXIII, p. 20 (January, 1907).

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussion, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

SUBSCRIPTION PRICE TO THE PUBLICATIONS OF THE SOCIETY

The following subscription rates have been fixed by the Board of Direction for the publications of the Society:

Proceedings, ten Numbers per annum, $8. Price for single numbers, $1.

Transactions, four Volumes per annum, $12. Price for single volumes, $4.

On the above prices there is a discount of 25% to members who desire extra copies of any of these publications, to Libraries, and to Book-dealers.

There is also an additional charge per annum, to cover foreign postage, of 75 cents for *Proceedings* and $1 for *Transactions,* or 8 cents and 25 cents, respectively, for single numbers.

A special subscription rate has been fixed by the Board for the *Proceedings* of the Society for the benefit of Students in Technical Schools. This rate is $4.50 per annum, and is available to any *bona fide* student of any technical school.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Friday of February, April, June, August, October, and November, and also on the third Wednesday of December, the latter being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., Assoc. M. Am. Soc. C. E., 713 Mechanics' Institute, 57 Post Street.

The by-laws of the Association provide for the extension of hospitality to any members of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest of the Association at any of the above meetings, if he will notify the Secretary that he is in San Francisco.

(Abstract of Minutes of Meetings)

August 19th, 1910.—The thirty-second regular meeting of the Association was held at the Palace Hotel; President Riffle in the chair; E. T. Thurston, Jr., Secretary; and present, also, 49 members and guests.

A discussion by Luther Wagoner, M. Am. Soc. C. E., on the paper entitled "The Ultimate Load on Pile Foundations: A Static Theory," by John H. Griffith, Assoc. M. Am. Soc. C. E., was read by the Secretary.

A paper by Charles Gilman Hyde, M. Am. Soc. C. E., on "A Study of the Present Water Supply of the City of Sacramento, and a Proposed Means of Improvement," was presented by the author, who illustrated his remarks with stereopticon views.

Adjourned.

October 21st, 1910.—The thirty-third regular meeting of the Association was held at the Place Hotel; President Franklin Riffle in the chair; E. T. Thurston, Jr., Secretary; and present, also, 90 members and guests.

Addresses were made by President Riffle, George W. Dickie, President of the Technical Society of the Pacific Coast, Edward F. Adams, President of the Commonwealth Club, and the Hon. Hugh McKenzie, and Elwood Mead, M. Am. Soc. C. E., respectively, Minister for Lands and Chairman, State Rivers and Water Supply Commission, of Victoria, Australia.

N. B. Kellogg, M. Am. Soc. C. E., was selected as the choice of the Association to represent District No. 7, on the Nominating Committee of the Society.

A paper was presented by James H. Wise, Assoc. M. Am. Soc. C. E., who gave a detailed description of the construction of the Lake Arthur earth dam in Placer County, illustrating his remarks with stereopticon views.

Adjourned.

Colorado Association

(Abstract of Minutes of Meeting)

October 8th, 1910.—The meeting was called to order at 8.15 P. M.; President Anderson in the chair; G. N. Houston, M. Am. Soc. C. E., acting as Secretary; and present, also, 18 members and 4 guests.

A paper by H. S. Crocker, M. Am. Soc. C. E., on "The Design and Construction of Creosoted Wood Block Pavement on the 20th Street

Viaduct," was presented by the author, and the subject was discussed by Messrs. Comstock, Prince, and one of the guests.

On motion by Mr. Comstock, a unanimous vote of thanks was extended to Mr. Crocker for his paper.

A further report on the Bill for Licensing Civil Engineers in the State of Colorado, was made by the Committee on Legislation. The suggestions brought out by the discussion at the September meeting of the Association having been embodied in the Bill, the discussion which followed, and in which nearly all members present took part, was confined to the sections affected by such changes.

Adjourned.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

Architekten=Verein zu Berlin, Wilhelmstrasse 92, Berlin W. 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, 718 Caxton Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Colorado Association of Members, Am. Soc. C. E., H. J. Burt, Secy., 235 Equitable Building, Denver, Colo.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 803 Fulton Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur- und Architekten-Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur- und Architekten-Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE LIBRARY

(From October 11th to November 7th, 1910)

DONATIONS*

GENERAL SPECIFICATIONS FOR STRUCTURAL WORK OF BUILDINGS.

By C. C. Schneider, Past-President, Am. Soc. C. E. Paper, 9 x 6 in., illus., 68 pp. New York, The Engineering News Publishing Company, 1910. 75 cents. (Donated by the Author.)

On October 19th, 1904, the author presented before this Society a paper entitled "The Structural Design of Buildings," in which was embodied a set of specifications for structural work for buildings. In the preface to this pamphlet it is stated that it is a reprint of the above-mentioned specifications, revised and brought up to date by the addition of tables and of drawings of standard columns and framing details. A chapter on Concrete and Reinforced Concrete in its application to building construction, has also been added, which, it is stated, is based on what the author "considers safe practice." These specifications for reinforced concrete are said to have been prepared after careful study of the regulations of the French, Prussian, Austrian, and Swiss Governments, the Association of German Architects and Engineers, etc., and the recommendations of the Special Committee on Concrete and Reinforced Concrete of this Society, with such modifications as have been suggested by the author's experience in such work. The recommendations of the Special Committee on Concrete and Reinforced Concrete of this Society have been adopted for that part of the specifications covering aggregates and the preparation and placing of concrete and mortar, as representing the best modern practice. The Contents are, Design: Loads; Unit Stresses and Proportion of Parts. Material and Workmanship. Concrete and Reinforced Concrete: Proper Use of Concrete; Improper Use of Concrete; Responsibility and Supervision; Specifications for Plain and Reinforced Concrete; Materials and Workmanship; Formulas for Approximate Computations. Appendix Containing Various Tables of Weights, Dimensions, etc.

RAILROAD FIELD GEOMETRY.

By William G. Raymond, M. Am. Soc. C. E. Leather, 7 x 4¼ in., illus., 10 + 246 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1910. $2.00. (Donated by the Author and the Publishers.)

In planning this book, the author states that he has departed from the usual brief formal statement of problem and solution by working out only a few of the less commonly used problems and leaving a considerable portion of the work for the student to do by indicated methods. After several chapters on the various methods of laying out curves on the ground and the solutions of problems which arise in this connection, there is a chapter on Spirals, the treatment of which the author states follows that of Talbot. This chapter contains some original work in the development of short formulas for practical use. The chapters on re-running old lines and preparing right of way descriptions are new, the subject in each case being treated by illustrative examples. Some portions of the chapter on Switches and Frogs, are stated to contain original methods which it is hoped may prove acceptable. The chapters on Earthwork are said to be a revised reproduction of the author's "Notes on Railway Earthwork," and it is hoped that the discussions of haul and mass diagram contained herein will lead to a clearing up of the question of overhaul and a general adoption of some rational method of procedure. The Contents are: The Railroad Line and Surveys; Simple Curves; Field Problems in Simple Curves; Compound Curves; Canting the Track on Curves; Spirals; Right of Way Description; Switches and Frogs; Rerunning Old Lines; Staking Out; Computing the Quantities; Areas, Volumes, Special Forms; Earthwork Tables; Diagrams; Haul; Mass Diagrams; Index.

THE CONSERVATION OF NATURAL RESOURCES IN THE UNITED STATES.

By Charles Richard Van Hise. Cloth, 8 x 5½ in., illus., 14 + 413 pp. New York, The Macmillan Company, 1910. $2.00.

The subject-matter contained in this book was first given as a series of twenty lectures at the University of Wisconsin. Special phases of the conservation of the natural resources of the United States have appeared, it is stated, in Government reports and magazine articles, but no correlated statement covering minerals, waters, forests, soils, and their relations to political economy and to lands, existing and desirable, is available. The author, therefore, has attempted to supply this deficiency in this handbook, which is said to contain the essential information which an intelligent citizen may desire in reference to the whole subject of conservation. The Contents are: Introduction: History of the Conservation Movement; Pt. I, The Mineral Resources: The Mineral Fuels; The Metallic Resources; The Non-Metallic Resources. Pt. II, Water: The Sources of Water; The Amount of Water; The Fly-Off; The Cut-Off; The Run-Off. Pt. III, Forests: The Original Forests; The Existing Forests; The Consumption of the Forest; Total Results of Measures Advocated; Concluding Statements. Pt. IV, The Land: The Soil; The Classification of the Land; The Ownership of the Land; The Farm Lands. Pt. V, Conservation and Mankind. Appendices: I, Delaration of Governors for Conservation of Natural Resources; II, North American Conservation Conference; III, National Conservation Association. Index.

---

* Unless otherwise specified, books in this list have been donated by the publishers.

INDEX TO *ENGINEERING NEWS* FOR THE YEARS 1905 TO 1909, INCLUSIVE.

Compiled by Mary E. Miller Gale. Cloth, 9 x 6 in., 335 pp. New York, The Engineering News Publishing Company, 1910. $2.50.

It is stated that this Index, like its three predecessors which covered the periods 1874-1890, 1890-1899, and 1900-1905, has been prepared and is published for the convenience of readers of *Engineering News*. The Index itself is a subject index and is said to cover only the reading matter contained in *Engineering News* and in the monthly supplement "Engineering Literature," omitting the "Construction News" supplement. Such matters as personals, obituary notices, etc., are not indexed unless they are of special importance. All articles on Reinforced Concrete have been grouped in this volume under "Concrete," and other changes will be found in the indexing of matter relating to streets, roads, and pavements. The reader's attention is also called to the fact that street railway matters are grouped under "Electric Railways"; railway track details under "Track"; and that power plants are chiefly under "Electric Power"; etc. An author index is appended for convenience in locating an article when the name of the author is known.

FACTORY ORGANIZATION AND ADMINISTRATION.

By Hugo Diemer. Cloth, 9½ x 6½ in., illus., 10 + 317 pp. New York and London, McGraw-Hill Book Company, 1910. $3.00.

The technical college graduate of to-day, the author claims, should be trained to fill positions in the stores, costs, employment or purchasing departments of manufacturing corporations, as well as in the designing, drafting, and testing departments. This book, it is stated, is intended for any student who desires to fit himself for such a position and to acquire a comprehensive grasp of the problems treated. It is said to be the result of twenty years' experience on the part of the author, and has acquired its present form from lecture courses delivered before senior students in engineering colleges. The Chapter Headings are: Industrial Engineering; The Economic Theory of Factory Location; The Planning of Factory Buildings and the Influence of Design on Their Productive Capacity; Staff and Departmental Organization; Executive Control in the Factory; Departmental Reports; The General Office; The Order Department; Bills of Material; The Drafting Department; The Pattern Department; The Purchasing Department; Stores and Stock Departments; The Production Department; Foundry Systems; The Machine Shop and Tool Department; Shipping and Receiving Departments; Time Taking; Cost Department; Aids in Taking Inventory; Inspection Methods in Modern Machine Shops; Employment of Labor and Labor Problems; Wage Systems; The Fixing of Piece Work Rates; Principles Underlying Good Management; A Bibliography of Works Management; Index.

MODEL BALLOONS AND FLYING MACHINES.

With a Short Account of the Progress of Aviation. By J. H. Alexander. Cloth, 7½ x 5 in., illus., 10 + 127 pp. New York, The Norman W. Henley Publishing Co.; London, Crosby Lockwood and Son, 1910. $1.50.

Both instruction and amusement, the author states, can be obtained by the making and flying of model aeroplanes, and this book has been written with a view to assist those who contemplate the construction of a model airship or flying machine. A short account of the progress of aviation is given, together with illustrations of typical specimens of full-sized airships and flying machines. At the end of the book five sheets of working drawings may be found, each sheet containing a different-sized machine. The Contents are: Early Balloon Voyages; The Spherical Balloon; The Parachute; The Airship, or Dirigible Balloon; A Model Fire Balloon; A Model Parachute; Inflating a Model Balloon with Gas; A Model Airship; Fundamental Principles of Flight; Gliders; Aeroplane Flights; Maxim's Flying Machine; Biplane and Monoplane Flying Machines; Model Flying Machines; Toy Flyer; Farman's Biplane; Model Voisin Aeroplane; Model Wright Aeroplane; Model Bleriot Aeroplane; Glossary of Terms used in Flight; The Building of a Flyer; Motive Power for Models; The Progress of Aviation; Index.

EXPÉRIENCES SUR LE TRAVAIL DES MACHINES-OUTILS: ALÉSAGE.

Par C. Codron. Paper, 12½ x 9 in., illus., 120 pp. Paris, H. Dunod et E. Pinat, 1910. 6 francs.

This study of drilling completes, it is stated, the series of articles by M. Codron on the use of machine tools for metals, which have appeared, in serial form, in *Revue de Mécanique.* The important and precise operation of drilling holes of small diameter is considered first, and descriptions of various types of hand drills are given, together with results obtained from their use in experiments with different metals. This is followed by a discussion of the boring of holes of large diameter with ordinary cutting tools and a description of the intricate comparative experiments undertaken in this connection, which, it is stated, will be found valuable in calculations for drilling machines. Numerous diagrams are included to facilitate a comparison of the results.

NOUVEAUX MÉCANISMES ET NOUVELLES MÉTHODES POUR L'ESSAI DES MÉTAUX.

Par Pierre Breuil. Paper, 12½ x 9 in., illus., 304 + 12 pp. Paris, H. Dunod et E. Pinat, 1910. 12 francs.

In this volume, the author, it is stated, has collected his studies on new machines and new methods for assaying metals. As former Chief of the Section of Metals of the Laboratoire d'Essais du Conservatoire des Arts et Metiers, he has had an opportunity to study the methods and machines described, and to examine critically any recent innovation in experiments with metals. He is thus able to present the subject impartially and authoritatively from all points of view. The subject-matter which was first published as a serial in *Revue de Mécanique,* from 1907 to 1909, has been revised to date and enlarged by the addition of new chapters and illustrations. It also contains a number of tables of results obtained by the author in his own work. The Contents are: But de l'Etude; Comment on peut Comprendre l'Expérimentation Pratique des Métaux; Sollicitations Lentes (Essais dits Statiques); Sollicitations Vives (Essais de choc); Sollicitations Localisées (Essais de Dureté).

AN AMERICAN TRANSPORTATION SYSTEM.

A Criticism of the Past and the Present and a Plan for the Future. By George A. Rankin. Cloth, 8 x 5½ in., 15 + 464 pp. New York and London, G. P. Putnam's Sons, 1909. $1.50.

As a result of an investigation of the requisites of an American transportation system, the author first discusses the following questions: (1) Is our railway system safe, efficient, economical, and just? (2) Does our railway system receive a fair return on its honest investments? (3) Is the management of our railway system such as to prevent it being used as a means of illegal gain? and (4) Is our railway system free from the corrupting influences of politics? This discussion is followed by an examination of proposed remedies which include a constitutional amendment that will bring the transportation monopoly under the control of the Federal Government, with a fixed law defining its duties, powers, and obligations, the abolishment of the present railway commissions, and the appointment instead of a court having the judicial power to inquire into the operation of such a transportation corporation and to which reports concerning the same shall be made. The Contents are: Introduction; Pt. I, The Wrong in our Transportation System; Pt. II, Legislative Attempts to Correct Wrongs in our Transportation System; Pt. III, A Suggested Constitutional Amendment; Index.

PLUMBING PLANS AND SPECIFICATIONS.

By J. J. Cosgrove. Cloth, 8½ x 5½ in., illus., 267 pp. Pittsburg, Standard Sanitary Mfg. Co., 1910. $3.00.

The author divides his subject-matter into four parts. Part I, it is stated, is devoted to a discussion of the advisability of a uniform system of symbols for indicating materials and fixtures on plumbing plans. Part II explains how to prepare plumbing plans and make up detail drawings of plumbing work. Plumbing specifications form the subject of Part III. A full working specification is given as a model, together with suggestions for writing such a specification and an analysis of its various clauses and conditions. The plumbing requirements for buildings of various types are discussed in Part IV, and examples of each class of building are shown. The Contents are: Plumbing Plans; Symbols for Plumbing Plans; Usual Type of Plumbing Plan; Improved Type of Plumbing Plans; Plumbing Details; Drawing Plumbing Plans; Plumbing Specifications; Example of a Plumbing Specification; Suggestions for Specification-Writing;

Analysis of Specifications; Planning Plumbing Work; Planning the Plumbing for Residences, Apartment Houses, School Buildings, Y. M. C. A. Buildings, Courthouses, Hotel Buildings, Club Buildings, Churches, Libraries, Fire Engine Houses, Factory Buildings, Office Buildings, Railway Stations. Printing Offices; Public Bath Houses; Public Playgrounds; Plumbing Work in Theatres, Hospitals, and Prisons; Planning Public Convenience Stations; Index.

PLUMBING ESTIMATES AND CONTRACTS.

By J. J. Cosgrove. Cloth, 8½ x 5½ in., illus., 203 pp. Pittsburg, Standard Sanitary Mfg. Co., 1910. $3.00.

The object of this work, the author states, is to present and explain the principles of estimating, contracting, and conducting a plumbing business. In the first part, he explains that to be successful as an estimator one must have a complete knowledge of materials, prices, locality, shipping, and be able to lay out work in an economical and sanitary way, and he points out some of the advanced principles of estimating as an aid to a beginner. The second part of the book is devoted to contracts and the business requirements of a successful contractor, and the third part is a discussion of the legal requirements to which a contract must conform, such as subject-matter, consideration, and mutual understanding. The laws of insurance and leases are also discussed. The Contents are: Part I, Estimates; Taking Off Quantities; Originality in Estimating; Estimating from Incomplete Plans; Making Up the Estimate; Calculating the Cost. Part II, Business of Contracts; Office Methods; The Execution of Contracts. Part III, Business Law. Index.

Gifts have also been received from the following:

Alabama, Univ. of. 1 pam.
Am. Ceramic Soc. 1 vol.
Am. Min. Congress. 1 pam.
Am. Soc. of Landscape Archts. 1 pam.
Annan, C. L. 1 pam.
Assoc. of Ontario Land Surv. 1 pam.
Baltimore & Ohio R. R. Co. 1 pam.
Bangor & Aroostook R. R. Co. 1 pam.
Bilbao, Spain-Junta de Obras del Puerto. 1 pam.
Cambridge, Mass.-Water Board. 1 pam.
Camden, N. J.-Water Dept. 1 pam.
Canada-Dept. of the Interior. 1 vol.
Canada-Geol. Survey. 1 vol.
Central Vermont Ry. Co. 1 pam.
Chicago & Eastern Illinois R. R. Co. 1 pam.
Chicago, Burlington & Quincy R. R. Co. 1 pam.
Chicago, Rock Island & Pacific Ry. Co. 1 pam.
Colorado, Univ. of. 1 pam.
Columbus, Ohio-City Council. 1 bound vol., 28 pam.
Conti, Luciano. 1 pam.
Crosby, Walter W. 1 bound vol.
Danzig, Germany, Königliche Technische Hochschule. 6 pam.
Decimal Assoc. 1 pam.
Dickinson, J. M. 1 pam.
Eddy, Harrison P. 1 vol.
Engrs. Soc. of Western Pennsylvania. 1 pam.
Erie R. R. Co. 2 pam.
Evansville & Terre Haute R. R. Co. 1 pam.
Florida-R. R. Comm. 2 pam.
Florida, Univ. of. 1 pam.
Germany-Preussiche Landesanstalt für Gewässerkunde. 1 pam.
Great Britain-Patent Office. 9 pam.
Great Northern Ry. Co. 1 pam.
Herbert, H. M. 1 bound vol.
Illinois-Canal Commrs. 1 bound vol.
Illinois Central R. R. Co. 2 pam.
Illinois Water Supply Assoc. 1 bound vol.
Indiana Eng. Soc. 1 vol.
Inst. of Civ. Engrs. of Ireland. 1 vol.
Inst. of Min. and Metallurgy. 1 bound vol.
Institution of Elec. Engrs. 2 pam.
Inter. Ry. Fuel Assoc. 1 bound vol.
Kentucky-Board of Agriculture. 2 pam.
Louisville & Nashville R. R. Co. 1 pam.
Madras, India-Public Works Dept. 1 pam.
Manchester Assoc. of Engrs. 1 bound vol.
Maryland-Weather Service. 3 bound vol.
Massachusetts-Auditor. 1 bound vol.
Mass. Inst. of Tech. 1 vol.
Mexican Ry. Co., Ltd. 4 pam.
Mississippi-Geol. Survey. 2 bound vol., 1 pam.
Montreal, Que.-Board of Health. 1 pam.
New Jersey-Board of Assessors. 2 bound vol., 1 pam.
New Jersey-Board of Health. 1 bound vol.
New Orleans, La.-Sewerage and Water Board. 1 pam.
New South Wales-Bureau of Statistics. 1 bound vol.
New York City-Board of Estimate and Apportionment. 1 pam.
New York City-Board of Water Supply. 1 bound vol.
New York State-Public Service Comm., First Dist. 31 vol., 6 pam.
New York City Record. 2 bound vol.
Newland, D. H. 1 pam.
North Carolina-Geol. Survey. 1 pam.
North Dakota, Univ. of. 1 pam.
North of England Inst. of Min. and Mech. Engrs. 3 pam.
Northern Pacific Ry. Co. 1 pam.
Ohio-Auditor. 1 bound vol., 4 pam.
Ohio-Highway Dept. 1 pam.
Ohio-Min. Dept. 1 bound vol.
Ohio-Secy. of State. 1 pam.
Ohio State Univ. 3 pam.
Pennsylvania-Senate Librarian. 1 bound vol.

Pennsylvania State Coll. 1 pam.
Pere Marquette R. R. Co. 1 pam.
Philippine Islands-Div. of Geol. and Mines. 1 pam.
Quebec Central Ry. Co. 1 pam.
Queensland-Commr. for Rys. 1 pam.
Reading, Pa.-Board of Water Commrs. 1 bound vol.
Rhode Island-Secy. of State. 1 bound vol.
Rhode Island-State Board of Health. 1 bound vol.
Rich, Edward D. 1 pam.
São Paulo, Brazil-Commissão Geographica e Geologica. 1 map.
U. S.-Bureau of Mines. 1 pam.
U. S.-Dept. of Agri. 2 pam.
U. S.-Corps of Engrs. 1 pam.
U. S.-Geol. Survey. 7 vol., 5 pam.
U. S.-Interstate Commerce Comm. 2 pam.
Virginia-State Corporation Comm. 2 bound vol.
Washington, Univ. of. 1 pam.
Western Australia-Commr. for Govt. Rys. 1 pam.
Wisconsin-R. R. Comm. 1 bound vol.

BY PURCHASE

Modern Road Building, Being Reports of the Transactions of the First Congress of American Road Builders Held at Seattle, Washington, July 4th, 1909. E. L. Powers, Secretary, A. R. B., Good Roads Magazine, New York.

Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, insbesondere aus den Laboratorien der technischen Hochschulen, herausgegeben vom Verein deutscher Ingenieure. Heft 88, 89, 90, 91 und 92. Julius Springer, Berlin, 1910.

Who's Who in British Engineering and Kindred Industries. The Eastern Press, Limited, London, 1910.

The Mechanical Engineering of Collieries: Heapsteads, Screening and Washing Plant. By T. Campbell Futers. The Colliery Guardian Co., Limited, London, 1909.

Royal Commission on Sewage Disposal; Supplementary Volumes Presented With the Fifth Report of the Commissioners, Appendix IV. Wymans & Sons, Limited, London, 1910.

High-Speed Steel; The Development, Nature, Treatment, and Use of High-Speed Steels, Together With Some Suggestions as to the Problems Involved in Their Use. By O. M. Becker. McGraw-Hill Book Company, New York, 1910.

Practical Data for the Cyanide Plant. By Herbert A. Megraw. McGraw-Hill Book Company, New York, 1910.

The Holland Land Co. and Canal Construction in Western New York: Buffalo-Black Rock Harbor Papers, Journals and Documents. Buffalo Historical Sooiety, Buffalo, 1910.

Railroad Administration. By Ray Morris. D. Appleton and Company, New York, 1910.

The Sources and Modes of Infection. By Charles V. Chapin. John Wiley & Sons, New York, 1910.

SUMMARY OF ACCESSIONS

(From October 11th to November 7th, 1910)

Donations (including 8 duplicates)	215
By purchase	14
Total	229

MEMBERSHIP

ADDITIONS

(October 12th to November 8th, 1910)

MEMBERS		Date of Membership.
Atwood, William Greene. Chf. Engr., L. E. & W. R. R., Indianapolis, Ind.	Assoc. M. M.	July 10, 1907 Nov. 1, 1910
Baum, Harry William. Contr. Mgr., Western Office, James Stewart & Co., First National Bank Bldg., Denver, Colo.		Oct. 4, 1910
Blodgett, John. Contr. Engr., Riverside Bridge Co., Martins Ferry, Ohio	Jun. Assoc. M. M.	Dec. 4, 1889 Jan. 2, 1901 Nov. 1, 1910
Brown, Frank Dudley. City Engr., Shawnee, Okla.		Oct. 4, 1910
Conover, Charles E. Designing Engr., New York State Public Service Comm., 1st Dist., 23 Flatbush Ave., Brooklyn, N. Y.		Nov. 1, 1910
Crockard, Frank Hearne. Vice-Pres. and Gen. Mgr., Tennessee Coal, Iron & R. R. Co., Birmingham, Ala.		Oct. 4, 1910
Darnell, James Lee. City Engr., 516 Midland Bldg., Kansas City, Mo.		Oct. 4, 1910
Gester, William Burr. Pacific Coast Representative, Robert W. Hunt & Co., 418 Montgomery St., San Francisco, Cal.		Oct. 4, 1910
Hansen, Andrew Christian. Mojave, Cal.		Oct. 4, 1910
Harris, Frederic Robert. Civ. Engr. in Chg., U. S. Navy Yard, U. S. Navy Yard, Brooklyn, N. Y.		June 30, 1910
Hayt, Robert Olcott. Asst. Engr., U. S. Reclamation Service, P. O. Box 551, Helena, Mont.	Assoc. M. M.	Oct. 3, 1906 June 30, 1910
Jewel, Lindsey Louin. Mgr. of Erection, McClintic-Marshall Constr. Co., Pittsburg, Pa.	Assoc. M. M.	April 4, 1906 Nov. 1, 1910
Jordán, Ricardo Tomás. Tech. and Commissary Insp., Tehuantepec National Ry., Rincón Antonio, Oax., Mexico		Oct. 4. 1910
Kimball, Herbert Sawyer. Chemical Engr. and Mill Archt., 46 Cornhill, Room 501, Boston, Mass.		Nov. 1, 1910
Nelson, Archy Magill. Asst. Engr., Ore. Short Line R. R. and S. P. Co., Room 518, Vermont Bldg., Salt Lake City, Utah		Oct. 4, 1910
Peck, John Gates. Chf. Engr. and Shop Mgr. for J. B. & J. M. Cornell Co., Cold Spring, N. Y.	Assoc. M. M.	Sept. 3, 1902 Nov. 1, 1910
Phillips, Frederick Clinton. Jacksonville, Fla.	Jun. Assoc. M. M.	June 4, 1895 April 4, 1900 Oct. 4, 1910

MEMBERS (*Continued*)

		Date of Membership.
Pitts, Thomas Dorsey. Div. Engr., Sewerage Comm., 904 American Bldg., Baltimore, Md.	Jun. Assoc. M. M.	Dec. 7, 1897 June 4, 1902 Oct. 4, 1910
Schulz, Walter Frederick. Engr. of Constr., Memphis Union Station Co., 681 Rayburn Boulevard, Memphis, Tenn.		Oct. 4, 1910
Shaw, George Harry Thornton. Chf. Engr., F. C. Mexico, Toluca y Pacifico, Apartado 77, Toluca, Mexico		Oct. 4, 1910
Stickle, Horton Whitefield. Capt., Corps of Engrs., U. S. A., Gatun, Canal Zone, Panama		Oct. 4, 1910
Whited, Willis. Asst. Engr., Dept. of Public Works, City Hall, Pittsburg, Pa.	Assoc. M. M.	Oct. 2, 1901 Nov. 1, 1910

ASSOCIATE MEMBERS

Allison, William Franklin. Prof. of Civ. Eng., Colorado School of Mines, Golden, Colo.		Oct. 4, 1910
Angel, Floyd Dwight. Engr. in Chg. of Location and Topography, U. S. Reclamation Service, Phœnix, Ariz.		Oct. 4, 1910
Barnard, Elmer Ellsworth. Asst. City Engr., Krise Bldg., Lynchburg, Va.	Jun. Assoc. M.	Jan. 31, 1905 May 3, 1910
Black, Ernest Bateman. Vice-Pres., The J. S. Worley Co., 207 Reliance Bldg., Kansas City, Mo.		Nov. 1, 1910
Brown, Seymour Dewey. Asst. to Pres. of Brazil Ry. Co. and of Port of Para, Brazil, 9 Rue Louis le Grand, Paris, France		Oct. 4, 1910
Bush, Adam Leonard. Chf. Engr. for Parkinson & Bergstrom, 1035 Security Bldg., Los Angeles, Cal.		Oct. 4, 1910
Case, George Wilkenson. Asst. Prof. in Eng., Purdue Univ., 113 South Grant St., West La Fayette, Ind.		Sept. 6, 1910
Cushing, Bruce Lincoln. Asst. Engr., Juragua Iron Co., Firmeza, Cuba		Oct. 4, 1910
Derrick, Clarence. 53 Beechwood Ave., Trenton, N. J.		Oct. 4, 1910
Dunglinson, George, Jr. Car Allotment Commr., Norfolk & Western Ry. Co., Bluefield, W. Va.		Nov. 1, 1910
Ebashi, Teiji. Care, Corrugated Bar Co., National Bank of Commerce Bldg., St. Louis, Mo.		Oct. 4, 1910
Edwards, Harold. 702 Builders Exchange, Winnipeg, Man., Canada		Sept. 6, 1910
Fisher, Wilbur Howard. 511 Waverly Pl., Spokane, Wash.	Jun. Assoc. M.	Dec. 6, 1904 Nov. 30, 1909
Fulweiler, Walter Herbert. With Dept. of Tests, United Gas Impvt. Co. of Philadelphia, Rose Valley, Moylan, Pa.		Nov. 1, 1910
Holbrook, Winfield. Res. Engr., Beaver Land & Irrig. Co., Penrose, Colo.	Jun. Assoc. M.	Mar. 3, 1908 Oct. 4, 1910

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Hufschmidt, William Paul. 725 Newport St., Denver, Colo.		Oct. 4, 1910
Jaques, Jacob Duncan. 26 North Brighton Ave., Atlantic City, N. J.		Nov. 1, 1910
Johnson, Natt Madison. Supt. of Concrete, Isthmian Canal Comm., Gatun, Canal Zone, Panama		Oct. 4, 1910
Land, John Thomas. Y. M. C. A., Jacksonville, Fla.		Oct. 4, 1910
Larkins, Edgar Ernest. (Consolidated Eng. Co.), 640 Bee Bldg., Omaha, Nebr.		Sept. 6, 1910
Magruder, Frank Cecil. Engr., U. S. Reclamation Service, Belle Fourche, S. Dak.	Jun. Assoc. M.	Sept. 6, 1904 Oct. 4, 1910
Nicolaysen, Albin Georg. Special Asst., R. R. and Canal Revaluation, State of New Jersey, 55 Broad St., Elizabeth (Res., 720 Leland Ave., Plainfield), N. J.	Jun. Assoc. M.	Dec. 1, 1908 Oct. 4, 1910
Palm, Thomas Jefferson. Res. Engr., Lometa West Line, Gulf, Colo. & Santa Fe Ry., San Saba, Tex.		Oct. 4, 1910
Parsons, Augustus Taber. Box 435, Bakersfield, Cal.	Jun. Assoc. M.	June 5, 1906 Oct. 4, 1910
Parthesius, Philip Henry. Senior Eng. Examiner with New York State Civil Service Comm., 119 Fourth St., Troy, N. Y.		Nov. 1, 1910
Pritchard, John Charles. Asst. Engr., Water Dept., 4245 Evans Ave., St. Louis, Mo.	Jun. Assoc. M.	Sept. 1, 1908 Oct. 4, 1910
Randolph, Robert Isham. Secy., Internal Impvt. Comm. of Illinois, 748 First National Bank Bldg., Chicago, Ill.	Jun. Assoc. M.	July 1, 1909 Nov. 1, 1910
Richmond, Jackson Litton. (Skene & Richmond), 125 Chestnut St., Evansville, Ind.		Oct. 4, 1910
Rightor, Fred Elmer. Office Engr., Texas Bitulithic Co., El Paso, Tex.		May 31, 1910
Slocum, Harry Spencer. Asst. Engr. with Vielé, Blackwell & Buck, 49 Wall St., New York City		Nov. 1, 1910
Toops, George Noble. Asst. Engr. on Constr., Ore. Short Line R. R. Co., Box 543, Pocatello, Idaho	Jun. Assoc. M.	April 5, 1910 Oct. 4, 1910
Wilhelm, George. Chf. Engr., Peoples Water Co., Oakland, Cal.		Oct. 4, 1910

ASSOCIATE

Gilmore, Alvin Leroy. 318 West 57th St., New York City	Jun. Assoc.	April 6, 1909 Oct. 4, 1910

JUNIORS

Behrman, Isadore. 1211 East Baltimore St., Baltimore, Md.		Oct. 4, 1910

JUNIORS (*Continued*)	Date of Membership.
Cartwright, Henry Hart. Surv., U. S. Govt., U. S. Engr. Office, Louisville, Ky	Oct. 4, 1910
Gaylord, Clifford Willard. Des Moines, Iowa	Oct. 4, 1910
Gill, Harold Earle. 9 Colden Ave., White Plains, N. Y.	Nov. 1, 1910
Gordon, Samuel. Asst. Civ. Engr., U. S. N., Navy Yard, Mare Island, Cal	Oct. 4, 1910
Harding, Harry Spear. Asst. Engr., New York Board of Water Supply, Walden, N. Y	May 31, 1910
Heiser, Alfred Brackenridge. Draftsman, Turner Constr. Co., 159 Twenty-third St., Brooklyn, N. Y	Nov. 1, 1910
Heiser, William Joseph. Designer and Estimator, National Bridge Works, 159 Twenty-third St., Brooklyn, N. Y	Nov. 1, 1910
Messer, Hope Richard. San. Engr., Dept. of Health of Virginia, 1110 Capitol St., Richmond, Va	Oct. 4, 1910
Reynolds, Leon Benedict. Herington, Kans	Oct. 4, 1910
See, Russell Alva. New Florence, Mo	Oct. 4, 1910
Spaulding, Ralph Edgar. Supt., The Aberthaw Constr. Co. of Boston, Mass., Suffield, Conn	May 31, 1910
Stanton, Harry Seel. Junior Engr., U. S. Reclamation Service, Engle, N. Mex	Oct. 4, 1910
Upton, Joseph. 109 Main St., Flushing, N. Y	Nov. 1, 1910
Whitman, Kilborn, Jr. Asst. Engr., Board of Water Supply of New York City, 523 West 122d St., New York City	Sept. 6, 1910

CHANGES OF ADDRESS

MEMBERS

Andersen, Christian. Cons. Engr., 251 Twelfth St., Portland, Ore.

Ash, Henry Clarke. 15 Carlisle Ave., Hunters Park, Duluth, Minn.

Aycrigg, William Anderson. Cons. Engr., 102 Chambers St., New York City.

Blauvelt, Louis David. Chf. Engr., The Denver, N. W. & Pac. Ry. Co., Room 718, Majestic Bldg., Denver, Colo.

Booth, William Henry. 19 Chatsworth Rd., West Norwood, S. E., London, England.

Collingwood, Francis. Cons. Engr., 211 South Broad St., Elizabeth, N. J.; Office address, 220 West 57th St., New York City.

Davison, George Stewart. Cons. Engr., 2512 Oliver Bldg., Pittsburg, Pa.

Earl, George Goodell. Gen. Supt., Sewerage and Water Board, Room 502, City Hall Annex, New Orleans, La.

Field, Frederick Elbert. Flood Comm. of Pittsburg, 1804 Arrott Bldg., Pittsburg, Pa.

Fisher, Edwin Augustus. City Engr., 30 Albemarle St., Rochester, N. Y.

MEMBERS (*Continued*)

FISK, WALTER LESLIE. Col., Corps of Engrs., U. S. A., 1322 Liggett Bldg., St. Louis, Mo.

FLAD, EDWARD. (Edward Flad & Co.), Fullerton Bldg., St. Louis, Mo.

FLOESCH, JACOB MARTIN. 5643 Northumberland Ave., Pittsburg, Pa.

GOODWIN, JAMES BOWMAN. Care, Mount Hood Ry. & Power Co., Bull Run, Ore.

HAMMOND, CHARLES ADRIAN. Mgr., Mt. Vernon Sewage Disposal Works, Columbus Ave., Foot of 7th St. (Res., 301 South 4th Ave.), Mt. Vernon, N. Y.

HARDING, JAMES JUDSON. Gen. Delivery, Long Beach, Cal.

HARTIGAN, FREDERICK LAWRENCE. 701 West 179th St., New York City.

HASLAM, EDWIN ERNEST. Civ. and Hydr. Engr., Hotel Columbia, Columbia, Pa.

HAYDEN, JOHN BRUCE. 376 Genesee St., Utica, N. Y.

HERRON, JOHN. Box 463, Palo Alto, Cal.

HOBBY, ARTHUR STANLEY. Cons. Engr., Box 37, Guayaquil, Ecuador.

JONES, ARTHUR LEWIS. Apartado No. 193, Mexico, D. F., Mexico.

KERR, FRANK MONTGOMERY. Chf. State Engr. of Louisiana, New Orleans Court Bldg., New Orleans, La.

KERR, HALBERT STEVENS. Manti, Utah.

KNOWLES, MORRIS. Cons., Municipal, San. and Hydr. Engr., 2548 Oliver Bldg., Pittsburg, Pa.

MACCALLA, CLIFFORD SHERRON. Asst. Gen. Mgr., The Washington Water Power Co., Box 2158, Spokane, Wash.

MATCHAM, CHARLES ARTHUR. Cons. Engr., 1727 Hamilton St., Allentown, Pa.

MILLIS, JOHN. Col., Corps of Engrs., U. S. A., U. S. Engr. Office, Room 420, Federal Bldg., Cleveland, Ohio.

MORRISON, HARRY JOHNSON. 201 Tremont St., Peekskill, N. Y.

MURALT, CARL LEONARD DE. Prof., Elec. Eng., Univ. of Michigan, Ann Arbor, Mich.

NORTON, ALBERT GRAY. 40 Houston Ave., Middletown, N. Y.

OLNEY, LAFAYETTE. Civ. Cons. Engr., Sea Cliff, N. Y.

PARKER, MAURICE STILES. St. Maries Hotel, St. Maries, Idaho.

RAYMOND, CHARLES WARD. Care, Ashton & Salisbury, Guaymas, Sonora, Mexico.

RICE, WALTER PERCIVAL. Civ. and Cons. Engr. (The Walter P. Rice Eng. Co.), 606 Osborn Bldg., Cleveland, Ohio.

ROBBINS, SAMUEL BOSTWICK. Care, Montana Reservoir & Irrig. Co., Bach-Cory Bldg., Great Falls, Mont.

SCHLECHT, WALTER WILLIAM. Care, Porto Rico Irrig. Service, Guayama, Porto Rico.

SMITH, WILLIS ROSWELL. Care, The Arnold Co., 181 La Salle St., Chicago, Ill.

STOWE, HAROLD CLAIR. Pres., H. C. Stowe Constr. Co., 221 Greenpoint Ave., Brooklyn, N. Y.

MEMBERS (*Continued*)

Sublette, George Washington. Cons. and Const. Engr. and Contr., 1926 Aldrich Ave. South, Minneapolis, Minn.

Sylvester, Frank McClellan. 1119 O. N. B. Bldg., Spokane, Wash.

Thompson, Fred. Civ. Engr., U. S. N., Navy Dept., Washington, D. C.

Winslow, Benjamin Emanuel. Structural Engr., 2540 North Sacramento Ave., Chicago, Ill.

Woodruff, Edward Lowrey. The Trebor Apartments, Los Angeles, Cal.

ASSOCIATE MEMBERS

Anderson, Robert Harlow. Parksville, Tenn.

Armstrong, Charles Johnstone. Care, Junior Naval and Military Club, 96 Piccadilly, W., London, England.

Balz, Louis Christian Frederick. Box 375, The Dalles, Ore.

Bayley, Charles Abercrombie Dunbar. 99 Heywood Ave., Orange, N. J.

Blanchard, Murray. 419 West 118th St., New York City.

Blaylock, John Charles. 2504 Harrison St., Kansas City, Mo.

Brady, Joseph. 17 Battery Pl., New York City.

Colvin, Donald Dean. Asst. Chf. Engr., Pan-American R. R. and Veracruz al Istmo R. R., Apartado 21, Tierra Blanca, Ver., Mexico.

Cook, Horace Arthur. Cons. and Constr. Civ. Engr., 31 West Adams St., Phœnix, Ariz.

Creelman, Charles Lauder. 613 Bankers Trust Bldg., Tacoma, Wash.

Edwards, Oliver Cromwell. Pres., The Pneumatic Caisson Co., Room 1000, Fifth Ave. Bldg., New York City (Res., 345 St. Johns Pl., Brooklyn, N. Y.).

Elbury, Thomas George. Municipal Contr., 552 Pacific Bldg., San Francisco, Cal.

Federlein, Walter Gottlieb. 611 West 127th St., New York City.

Fenstermaker, DeWitt Clinton. Means, Ohio.

Griswold, Harry Todd. Old Lyme, Conn.

Hanna, Walter Scott. Prin. Asst. Engr., with J. B. Hogg, 828 Park Bldg., Pittsburg, Pa.

Hawkins, Irving. 61 Wall St., Kingston, N. Y.

Holt, Lester Morton. 3551 Thirteenth St., N. W., Washington, D. C.

Hough, Frederick Milton. Contr. Engr., Brownsville, Tex.

Johnson, George Arthur. (Johnson & Fuller), 150 Nassau St., New York City.

Kast, Clarke Nightingale. Dist. Engr., Bureau of Public Works, Manila, Philippine Islands.

Kauffman, Vernet Albert. 1768 Emerson St., Denver, Colo.

Kyle, Ralph Briggs. 236 Fourteenth St., San Pedro, Cal.

Lannan, Louis Edgar. Asst. Engr., Westchester & Northern R. R., 69 Hale Ave., White Plains, N. Y.

McClelland, Claude Leslie. West 4th St., Ontario, Cal.

McMorrow, James Walter. Secy., McMorrow Eng. & Constr. Co., 3785 Broadway (Res., 551 West 170th St.), New York City.

ASSOCIATE MEMBERS (*Continued*)

Mahon, Ross Le Hunt. Care, Riverside Printing Co., Port Huron, Mich.

Miner, James Henry. Project Engr., U. S. Reclamation Service, Grand Junction, Colo.

Morssen, Charles Michael. 747 St. Catherine St., West, Room 24, Montreal, Que., Canada.

Nikolitch, Milan. Designing Engr., S. P. Co., 2211 Ellsworth St., Berkeley, Cal.

Nolen, William Isaac. Copperhill, Tenn.

Perley, Alan Bigelow. 46 Gowen St., Mt. Airy, Pa.

Pflueger, Alvin Cyrus. Asst. Engr., P. T. & T. R. R. Co., 45 East 33d St., New York City.

Poole, John Hudson. 1216 Ford Bldg., Detroit, Mich.

Robb, Louis Adams. 71 Lincoln Park, Newark, N. J.

Robinson, Frank Miner. Asst. Engr., West. Pac. Ry., Box 42, Portola, Cal.

Sanger, Edmund Phipps. 154 West 121st St., New York City.

Simpson, Erastus Roland. 89 St. Botolph St., Boston, Mass.

Smith, Russell Biddle. 1020 Land Title Bldg., Philadelphia, Pa.

Soule, Edward Lee. Structural Engr., with Jno. B. Leonard, 2532 Hillegas Ave., Berkeley, Cal.

Spear, Philip Hichborn. Asst. Engr., N. Y. C. & H. R. R. R., Hastings-on-Hudson, N. Y.

Thurston, Eugene True, Jr. Designing and Constr. Engr., 57 Post St., San Francisco, Cal.

Toltz, Max. Gen. Mgr., Manistee & Grand Rapids R. R., 702 Capitol Bank Bldg., St. Paul, Minn.

Tudbury, Warren Chamberlain. Asst. Engr., N. Y. C. & H. R. R. R. Co., 33 Main St., Utica, N. Y.

White, Byron Ellsworth. 15 Steuben St., Utica, N. Y.

Woodle, Allan Sheldon, Jr. Care, The Standard Steel Works Co., Narberth, Pa.

ASSOCIATE

Ray, David Heydorn. Chf. Engr., Bureau of Bldgs. of New York City, 220 Fourth Ave. (Res., 329 Edgecomb Ave.), New York City.

JUNIORS

Armstrong, George Simpson, Jr. Care, The Carpenter Steel Co., Reading, Pa.

Atwood, Chester Ely. Care, Franklin Irrig. Co., Franklin, Mont.

Battie, Herbert Scandlin. Box 126, Harrisburg, Pa.

Bellows, Sidney Raymond. Care, Barge Canal Office, 82 Parker Bldg., Schenectady, N. Y.

Bishop, Hiram Nelson. 319 Boren Ave., Seattle, Wash.

Black, Roger Derby. 1st Lieut., Corps of Engrs., U. S. A., Care, Headquarters, Dept. of California, Chronicle Bldg., San Francisco, Cal.

Carter, Lester Levi. Care, Associated Pipe Line Co., Los Banos, Cal.

Chevalier, Willard Townshend. Asst. Engr., Public Service Comm., 1st Dist., 23 Flatbush Ave., Brooklyn, N. Y.

JUNIORS (*Continued*)

Dimmler, Charles Louis. 319 Boren St., Seattle, Wash.

Foss, James Calvin, Jr. 1835 Makiki St., Honolulu, Hawaii.

Gibble, Isaac Oberholzer. Levelman, M. of W. Dept., Houston Div., Galveston, Harrisburg & San Antonio Ry. Co., San Antonio, Tex.

Gram, Ralph Samuel. 218 La Salle St., Room 922, Chicago, Ill.

Greathead, John Francis. 719 North Washington St., Rome, N. Y.

Haney, Albert Paul. 3814 Westminster Pl., St. Louis, Mo.

Henley, Robert Dwiggins Monteith. Care, C. F. W. Felt, Chf. Engr., A., T. & S. F. Ry. Co., Topeka, Kans.

Hohl, Leonard Louis. 1834 Delaware St., Berkeley, Cal.

Hutchins, Harry Crocker. Care, Public Service Comm., 51 Chambers St., Room 207, New York City.

Karnopp, Edwin Benjamin. Div. Engr., Madeira-Mamoré Ry., Box 304, Manãos, Brazil.

Leonard, Edward Philip. Care, The Sperry Eng. Co., 82 Church St., New Haven, Conn.

Lewis, Chester Brooks. With C. W. Humphrey, 618 Rookery Bldg., Chicago, Ill.

Montero, Julio Daniel. Enramadas Alta No. 34 (Altos), Santiago de Cuba, Cuba.

Moore, Stanley Wallace. Asst. Mgr., Manila Constr. Co., Box 590, Manila, Philippine Islands.

Nichol, Henry Schell. Care, Canadian Collieries, Ltd., Victoria, B. C., Canada.

Okes, Day Ira. Chf. Engr., Kettle River Co., 218 North 5th St., Minneapolis, Minn.

Pill, Leon Morley. 1225 Eleventh Ave., South, Birmingham, Ala.

Reimann-Hansen, Robert Louis. Draftsman, B. & O. R. R., 3637 Park Heights Ave., Baltimore, Md.

Russell, Alexander Stuart. Petersburg, Mich.

Ryan, Richard R. 222 Ferris St., Sault Ste. Marie, Mich.

Shaw, Walter Farnsby. Care, Barge Canal Office, R. F. D. No. 5, Rome, N. Y.

Taylor, Warren Crosby. Instr. in Civ. Eng., Union Univ., Schenectady, N. Y.

Tyler, William Rogers. 3 West 92d St., New York City.

DEATHS

Dawley, Edwin Peleg. Elected Member, April 1st, 1885; died October 7th, 1910.

Harding, Henry. Elected Member, May 7th, 1873; died October 23d, 1910.

Lord, Harold. Elected Junior, September 3d, 1907; date of death unknown.

Robinson, Stillman Williams. Elected Member, January 2d, 1884; died October 3d, 1910.

Total Membership of the Society, November 8th, 1910,
5 737.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(October 11th to November 7th, 1910)

Note.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal,* Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings,* Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions,* Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly,* Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator,* Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine,* New York City, 25c.
(10) *Cassier's Magazine,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News,* New York City, 15c.
(14) *The Engineering Record,* New York City, 12c.
(15) *Railway Age Gazette,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway and Engineering Review,* Chicago, Ill., 10c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 10c.
(21) *Railway Engineer,* London, England, 25c.
(22) *Iron and Coal Trades Review,* London, England, 25c.
(23) *Bulletin,* American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal,* New York City, 10c.
(25) *American Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique,* Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France.
(34) *Portefeuille Economiques des Machines,* Paris, France.
(35) *Nouvelles Annales de la Construction,* Paris, France.
(37) *Revue de Mécanique,* Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways,* Paris, France.
(41) *Modern Machinery,* Chicago, Ill., 10c.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Pontes et Chaussées,* Paris, France.
(44) *Journal,* Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals,* Scranton, Pa., 20c.
(46) *Scientific American,* New York City, 8c.
(47) *Mechanical Engineer,* Manchester, England.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(51) *Deutsche Bauzeitung,* Berlin, Germany.
(52) *Rigasche Industrie-Zeitung,* Riga, Russia.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions,* Am. Soc. C. E., New York City, $4.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $5.

(57) *Colliery Guardian,* London, England.
(58) *Proceedings,* Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.
(59) *Transactions,* Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.
(60) *Municipal Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *Industrial World,* 59 Ninth St., Pittsburg, Pa.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 20c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Journal of Gas Lighting,* London, England, 15c.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(68) *Mining Journal,* London, England.
(70) *Engineering Review,* New York City, 10c.
(71) *Journal,* Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London England.
(73) *Electrician,* London, England, 18c.
(74) *Transactions,* Inst. of Min. and Metal., London, England.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
(76) *Brick,* Chicago, Ill., 10c.
(77) *Journal,* Inst. Elec. Engrs., London, England.
(78) *Beton und Eisen,* Vienna, Austria.
(79) *Forscherarbeiten,* Vienna, Austria.
(80) *Tonindustrie Zeitung,* Berlin, Germany.
(81) *Zeitschrift für Architektur und Ingenieurwesen,* Wiesbaden, Germany.
(83) *Progressive Age,* New York City, 15c.
(84) *Le Ciment,* Paris, France.
(85) *Proceedings,* Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.
(86) *Engineering-Contracting,* Chicago, Ill., 10c.
(87) *Roadmaster and Foreman,* Chicago, Ill., 10c.
(88) *Bulletin* of the International Ry. Congress Assoc., Brussels, Belgium.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa.
(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(94) *The Boiler Maker,* New York City, 10c.
(95) *International Marine Engineering,* New York City, 20c.
(96) *Canadian Engineer,* Toronto, Ont., Canada, 15c.
(97) *Turbine,* Berlin, Germany, 1 Mark.
(98) *Journal,* Engrs. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $1.50.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., $1.
(101) *Metal Worker,* New York City, 10c.
(102) *Organ für die Fortschritte des Eisenbahnwesens,* Wiesbaden, Germany.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, Eng., 6d.
(105) *Metallurgical and Chemical Engineering,* New York City, 25c.

LIST OF ARTICLES.

Bridges.

Stone Highway Bridges, the Stress Diagram, with its Application to Design of Masonry Bridge.* J. H. Everest. (104) Oct. 7.
The Penhorn Creek Viaduct of the Erie Railroad.* (13) Oct. 13.
The Electrical Operation of Drawbridges. S. F. Nichols. (Abstract of paper read before the Assoc. of Ry. Elec. Engrs.) (13) Oct. 13; (18) Oct. 22.
Reinforcement of the Pecos River Viaduct.* (15) Oct. 14; (14) Oct. 29; (13) Nov. 3.
The Galveston Causeway.* (14) Oct. 15.
The St. Louis Municipal Bridge Substructure.* (14) Oct. 15.
Building and Sinking the Quebec Bridge North Caisson.* (14) Oct. 15.
The Providence Station Viaduct.* (14) Oct. 22.
Superelevation on Bridges.* (Report of Comm. Amer. Bridge and Bldg. Assoc.) (18) Oct. 22.
Double Tracking the C. P. R. St. Lawrence River Bridge.* (96) Oct. 27.
Standard Solid Floor Trestles.* (14) Oct. 29.
Construction d'un Pont sur l'Ourthe à Durbuy.* J. Duvigneaud.* (30) Oct.
Herstellung einer Eisenbetonbrücke in zwei Bauabschnitten.* Hermann Roch. (78) Sept. 24.
Ueber zulässige Spannungen im Eisen, im Hoch- und Brückenbau. Schüle. (78) Oct. 7.

---

* Illustrated.

Electrical.

Resonance in Alternating Current Circuits.* J. Dalemont. (5) Jan.
One of the Problems of Submarine Cable Telegraphy, with a Possible Solution.* E. S. Huertley. (5) Jan.
A Telephone Relay.* S. G. Brown. (77) Sept.
Standardisation of Fuses.* H. W. Kefford. (77) Sept.
Isolated Electrical Plants.* R. C. Plowman. (77) Sept.
The Theory and Design of Current Transformers.* Arthur P. Young. (77) Sept.
Collection of Current at High Peripheral Speeds.* P. J. Cottle and J. A. Rutherford. (77) Sept.
The High-Tension Spark Discharge in Air.* Philip Kemp and William Arthur Stephens. (77) Sept.
Localisation of Breaks in Submarine Cables.* W. H. Young. (77) Sept.
The Theory of the Static Balancer. C. C. Hawkins. (77) Sept.
Depreciation and Reserve Funds of Electrical Properties. William B. Jackson. (4) Oct.
Diversity Factor in the Distribution of Electric Light and Power.* H. B. Gear. (4) Oct.
Leakage Reactance.* J. Rezelman. (73) Oct. 7.
Experimental Apparatus for Wireless Telephony.* (73) Oct. 7.
Costs and Methods of Replacing Five Miles of 1-0 Overhead Construction by 4-0 Construction.* T. T. Logie. (86) Oct. 12.
Multi-Speed Squirrel-Cage Induction Motor. R. E. Hellmund. (27) Oct. 13.
Specifications for Overhead Crossings of Electric Transmissions Lines. (Abstract of report to the Amer. St. and Interurban Ry. Eng. Assoc.) (17) Oct. 13.
Properties of the Most Important Detectors used in Wireless Telegraphy.* K. Bangert. (Tr. from *Physikalische Zeitschrift.*) (73) Oct. 14.
The Regulation of Telephone Rates and Service in Massachusetts. (13) Oct. 20.
The Street Lighting of Dowlais.* Lewis Wm. Dixon. (26) Oct. 14; (73) Oct. 21.
The 1910 Edison Storage Battery.* Walter E. Holland. (Paper read before the Assoc. of Edison Illum. Cos.) (73) Serial beginning Oct. 21.
Electrical Equipment of the Plymouth Electric Light Company.* (27) Oct. 27.
Graphic Representations of the Linear Electrostatic Capacity Between Equal Parallel Wires.* A. E. Kennelly. (27) Oct. 27.
American Telephone Practice: A Comparison of Manual and Automatic Systems. J. J. Carty, M. Am. Inst. E. E. (Abstract from paper read before the Inter. Con. of Telephone and Telegraph Administrations.) (13) Oct. 27.
Yngeredsfors Power Plant and 40 000-Volt Transmission Line to Varberg and Mölndal-Gothenburg (Sweden).* Henry Chervet. (73) Serial beginning Oct. 28.
Submarine Cable Laying, P. R. R.* (18) Oct. 29.
Interpoles in Synchronous Converters. B. G. Lamme and F. D. Newbury. (42) Nov.
Vacuum-Tube Lighting.* D. McFarlan Moore. (3) Nov.
Some Recent Problems in Storage Battery Engineering.* Joseph Appleton. (3) Nov.
Versuche und Berechnung von Siegwartmasten.* F. Steiner (78) Oct. 7.

Marine.

Submarines.* Simon Lake. (2) Oct.
The Influence of Depth on Speed of French Destroyers.* (12) Oct. 21.
Rules for Shipbuilding. Arthur R. Liddell. (12) Oct. 21.
Turbine Troubles (Marine). (12) Oct. 21.
The White Star Liner *Olympic.** (11) Oct. 21; (12) Oct. 21.
Raising the United States Battleship *Maine.** (14) Oct. 22; (13) Oct. 20.
Motor Boat Propulsion.* (12) Serial beginning Oct. 28.
The Naval Yard at the Cape of Good Hope.* (11) Serial beginning Oct. 28.
Some Data on Paddle-Wheel Steamers.* Claude A. Anderson. (95) Nov.
Twin Screw Tunnel Steamers vs. Sternwheelers for Service on the Western Rivers.* Charles E. Ward. (95) Nov.
A Proposed Design for a Stern-Wheel River Steamer.* (95) Nov.
Extension du Port d'Anvers; Construction du Tronçon-Sud du Bassin Canal et des Deux Darses Correspondantes, Description des Chantiers.* C. Missoten et F. Zanen. (30) Oct.
Motorboot aus Eisenbeton.* (78) Oct. 27.

Mechanical.

Recent European Progress in Dirigible Balloons.* W. A. Blonck. (4) Oct.
Brickmaking on the Hudson.* (76) Oct.
A New Process for the Rapid Estimation of Sulphur and Sulphuretted Hydrogen in Illuminating Gas.* C. Winthrope Somerville. (66) Oct. 4.
The Thermal and Thermo Dynamic Efficiency of Town Gas in Practice. Thomas Canning. (Paper read before the Inst. of Gas Engineers.) (66) Oct. 4.

---

*Illustrated.

Mechanical—(Continued).

Extensions at Burton (Gas-Works).* R. S. Ramsden. (Paper read before The Midland Junior Gas Assoc.) (66) Oct. 11.

Coal-Tar Distillation. Arthur R. Warnes. (Paper read before the Midland Junior Gas Assoc.) (66) Oct. 11.

A Small Power Plant with Modern Features.* L. L. Brewster. (64) Oct. 11.

Methods and Cost of Unloading Crushed Rock from Railroad Cars and Hauling the Same to the Road; a Railroad Car for Hauling Crushed Rock.* H. R. Postle. (86) Oct. 12.

Report of the Comm. on Power Generation (Amer. St. and Inter. Ry. Eng. Assoc.) H. G. Stott and others. (17) Oct. 13.

Evaporative Tests of a Nicolson Boiler.* Michael Longridge, M. Inst. C. E. (47) Oct. 14.

Air Lift Pumping.* Edward A. Rix. (103) Oct. 15.

Heat, Light and Power in Buildings, Some Operating Details of the Modern Structure.* (101) Oct. 15.

Chemical Control of Oil Gas Manufacture. E. L. Hall. (Paper read before the Pacific Coast Gas Assoc.) (24) Oct. 17; (83) Nov. 1.

Large Southern Cotton Mill Plant.* Warren O. Rogers. (64) Oct. 18.

The Inland Steel Company's Works, Description of the Indiana Harbor Sheet Mills.* (20) Oct. 20.

Oil and Gas Fuel Station at Wichita, Kan.* (27) Oct. 20.

Flow of Gas in Pipes. E. A. Hitchcock. (Abstract of Report to City of Columbus, O.) (96) Oct. 20.

Fast versus Slow-Speed Motors for Cars.* (11) Oct. 21.

New Mill at the Works of the English McKenna Process Company, Limited.* (22) Oct. 21.

The Practice and Theory of Aviation.* Grover Cleveland Loening. (19) Serial beginning Oct. 22.

Testing of Heat-Insulating Materials.* F. Bacon. (Abstract of paper read before the Brit. Assoc.) (47) Oct. 21.

Physical Properties of Cast Iron. John J. Porter. (Paper read before the Amer. Foundrymen's Assoc.) (47) Oct. 21.

Gas Making at Guilford, a New Retort House.* (66) Oct. 25.

The Cost of Heat, Light and Power.* C. M. Ripley. (64) Oct. 25.

Tests of Traction Engines at Winnipeg, Canada. (13) Oct. 27.

A Recording Weigher for Liquids.* (13) Oct. 27.

The Improvement of Steam Plant Efficiency. Carl C. Thomas. (Abstract from *Wis. Engr.*) (96) Oct. 27.

Recent Developments at Carville Power Station.* (26) Oct. 28.

Water-Tube Boilers. D. Wilson. (Abstract of paper read before the Manchester Assoc. of Engrs.) (47) Oct. 28.

Portland Cement Works in Sweden.* (12) Oct. 28.

Aeroplanes in Paris.* (12) Serial beginning Oct. 28.

The Acetylene Welding Torch.* J. F. Springer. (25) Nov.

Mechanical Engineering Problems in Illuminating Gas Works.* J. A. P. Crisfield. (3) Nov.

A Coal-Loading Machine.* William Whaley. (45) Nov.

European Lift-Valve Engines.* Warren H. Miller. (9) Nov.

Power Required for Rolling Steel. J. A. Knesche. (9) Nov.

Power Plant of McCormick Building.* Osborn Monnett. (64) Nov. 1.

The Manufacture of Sublimed White Lead.* J. I. Blair. (16) Nov. 5.

Evolution Pratique de la Machine à Vapeur; Machine à Expansion Multiple ou Machine Compound.* A. Mallet. (32) Serial beginning Aug.

Les Essais des Moteurs d'Aviation. A. Boyer-Guillon (37) Sept. 30.

Les Installations de Chauffage et d'Electricité à l'Observatoire Royal de Belgique à Uccle.* A. Hermant. (30) Oct.

La Manutention Mécanique des Minerais par des Ponts Roulants Culbuteurs à Grand Rendement.* Siegfried Levi. (33) Oct. 8.

La Transformation des Usines Elévatoires de la Ville de Lyon.* (33) Oct. 22.

L'Emploi des Tubes Annulaires dans les Appareils Réfrigérants et les Echangeur de Chaleur. (33) Oct. 22.

Tentative de Traversée de l'Atlantique par M. Wellman, sur son Ballon Dirigeable *America*.* Ch. Dantin. (33) Oct. 22.

Brenntorfgewinnung nach Dr. Ekenbergs Verfahren (Nassverkoklung). M. Glaseknapp (52) Sept. 15.

Motorwagen und Fahrzeugmaschinen für flüssigen Brennstoff auf der Weltausstellung in Brüssel, 1910.* A. Heller. (48) Serial beginning Oct. 8.

Gegenwärtiger Stand der Formmaschinenarbeit und des Formmaschinenbaues.* Carl Irresberger. (50) Oct. 12.

Vom Kleinsten zulässigen Ungleichförmigkeitsgrad für Zentrifugal-Pendelregler. (53) Oct. 14.

Versuche zur Ermittlung der günstigsten Arbeitsweise der Rundschleifmaschine, ausgeführt im Sommer 1908.* W. Pockrandt. (48) Serial beginning Oct. 15.

Ueber neuere Lauftrommeln für Dampfturbinen.* W. Gentsch. (97) Oct. 20.

---

*Illustrated.

Mechanical—(Continued).

Ergebnisse der Untersuchung von Kesselblechen, bei denen Rissbildungen aufgetreten sind.* C. Bach. (48) Oct. 22.
Ueber Koksofensteinzerstörungen und deren Ursachen.* F. Schreiber. (50) Oct. 26.
Versuche über Walzdrucke an einem Blockwalzwerk.* J. Puppe. (50) Serial beginning Oct. 26.

Metallurgical.

Some Analyses of Copper Blast Furnace Slags and Determination of their Melting Points.* A. T. French. (74) Vol. 19.
Experiments in Reverberatory Practice at Cananea, Mexico.* L. D. Ricketts. (74) Vol. 19.
Native Iron Smelting in Haute Guinée (West Africa).* J. Morrow Campbell. (74) Vol. 19.
A Modification of Pachuca-Tank Practice.* Amos J. Yager. (103) Oct. 22.
Electrostatic Separation. Henry A. Wentworth. (103) Oct. 29.
Modified Cyanide Process. (105) Nov.
Appareil de Microphotographie.* F. Robin. (93) Oct.
Sur la Nature des Scories Interposées dans l'Acier Thomas.* M. Matweieff. (93) Oct.
Sur la Cémentation par les Gaz.* A. Portevin. (93) Oct.
Ueber die Ursachen der Brennstoffersparnis und der Mehrerzeugung beim Hochofenbetrieb durch die Verwendung erhitzen und getrockneten Windes.* F. Wüst. (50) Oct. 5.

Military.

Gun Erosion. Philip R. Alger. (12) Oct. 14.
A Hollow-Handled Intrenching Tool for Infantry.* Harry H. Bissell. (From *Le Spectateur Militaire.*) (44) Nov.

Mining.

The Elements of Slime Concentration.* Walter McDermott. (74) Vol. 19.
Grading Analyses and their Application.* H. Stadler. (74) Vol. 19.
Notes on Hammer Drill Work at the Granite Mines, B. C.* H. B. Williams. (74) Vol. 19.
The Development of Heavy Gravitation Stamps.* W. A. Caldecott. (74) Vol. 19.
Tin Production in the Province of Yunnan, China.* W. F. Collins. (74) Vol. 19.
Copper Leaching Plant in the Ural Mountains.* A. L. Simon. (74) Vol. 19.
The Surface Condenser in Mining Power Plant.* W. A. MacLeod. (74) Vol. 19.
Earth versus Insulated Neutrals in Colliery Installations.* W. Wellesley Wood. (77) Sept.
Rescue Stations in Illinois Coal Mining Localities. R. Y. Williams. (4) Oct.
Electric Haulage in Mines.* Arthur Hall, M. Inst. M. E. (Paper read before the National Assoc. Colliery Mgrs.) (22) Oct. 7.
Testing Placers in Korea.* R. Y. Hanlon. (101) Oct. 8.
Notes on the Construction of California Dredges.* John Tyssowski. (16) Oct. 15.
The Safety of Winding Ropes. F. Baumann. (From *Gluckauf.*) (22) Oct. 21.
Agglomerating Ore Fines and Flue Dust.* Herbert Haas. (16) Oct. 22.
Method and Cost of Lining a Mine Shaft with Concrete.* R. H. Worcester. (86) Oct. 26.
Present Tendencies in Cyanide Practice. Mark R. Lamb. (16) Oct. 29.
Dredging Conditions on the Seward Peninsula.* G. B. Massey, II. (16) Oct. 29.
Kellerman Mine, Kellerman, Ala.* Neill Hutchins. (45) Nov.
Coal Mining in Oklahoma.* Willis P. Thomas. (45) Nov.
Mining Cement Gravel at Altar.* Aloysius Coll. (45) Nov.
Blasting Supplies.* F. H. Gunsolus. (45) Nov.
Mining Methods Employed at Cananea, Mex.* Morris J. Elsing. (16) Serial beginning Nov. 5.
L'Extraction du Minerai de Fer dans le Bassin Normand.* S. Brull. (33) Oct. 15.
Essais sur les Inflammations de Pousières (Comité Central des Houillères de France).* J. Taffanel. (93) Oct.; (57) Oct. 21.

Miscellaneous.

The Pyrometer, its Development and Use.* William H. Bristol. (41) Serial beginning Oct.
The Weather in Relation to Municipal Engineering. Harold G. Turner. (104) Oct. 14.
The Galveston Causeway.* (14) Oct. 15.
A Study of Sleet Loads and Wind Velocities.* Frank F. Fowle. (27) Oct. 27.

---

*Illustrated.

Municipal.

County Roads Systems in the Province of Ontario, Canada. (86) Oct. 12.
Tarring Roads: High-Pressure Rollers. Reginald Ryves, Assoc. M. Inst. C. E. (104) Oct. 28.
Highway Dust Reduction in the Urban District of Alton. G. Bertram Hartfree. (Paper read before the Inst. of Mun. and County Engrs.) (104) Oct. 28; (14) Oct. 15.
The Victoria Embankment Pavement. (14) Oct. 22.
Close-Jointed Granite Block Pavement, Newark, N. J. (14) Oct. 22.
Surface Treatment of Roads in a Residential City. Charles W. Ross. (Abstract of paper read before the National Good Roads Convention.) (86) Oct. 26; (14) Oct. 15.
Road Drainage. (Abstract of report of Engr. of Highways, Ontario.) (86) Oct. 26.
Pipe Subways in Cities. (14) Oct. 29.
Standard Specifications of the Road Commissioners of Wayne County, Michigan, for a Single Course Concrete Road for a Trunk Road. (86) Nov. 2.
Tests of Creosoted Wood Paving Blocks.* W. K. Holt. (Abstract from *Proc.* Indiana Eng. Soc.) (86) Nov. 2.
Experiments in Binding Gravel and Crushed Gravel with Tar and Asphalt and in Constructing a Water Bound Road of Gravel. (Abstract from *Bul.*, Ohio State Highway Dept.) (86) Nov. 2.

Railroads.

Grade Separation. W. H. Breithaupt. (5) Jan.
Large Stations, Subject for Discussion at the Eighth Railway Congress.* A. Kain. (88) Aug.
Note on the Electric Treadles for Locking the Points on the Belgian State Railways.* L. Weissenbruch and J. Verdeyen. (88) Aug.
British Locomotives in 1909, Designs and Work.* J. F. Gairns. (88) Aug.
Automatic Connectors for Freight and Passenger Train Cars.* Willis C. Squire. (61) Sept.
Methods and Costs of Surfacing and Smoothing Track. D. A. Wallace. (87) Oct.
Construction of a Rapid Transit Railroad in Relation to the Handling of Passengers, as Illustrated by the Hudson and Manhattan Railroad. J. Vipond Davies. (2) Oct.
Economic Considerations Governing the Selection of Electric Railroad Apparatus.* F. Darlington. (4) Oct.
Reinforced Concrete Trestles for Railways.* C. H. Cartlidge. (4) Oct.
Superheating on London and Northwestern Locomotives.* (12) Oct. 7; (11) Oct. 7.
Theory of Rail Joints.* Felix Lange. (Abstract of paper read before the Amer. St. and Interurban Ry. Eng. Assoc.) (17) Oct. 12; (96) Oct. 27.
Report of Committee on Way Matters. (Amer. St. and Interurban Ry. Eng. Assoc.) E. O. Ackerman and others. (17) Oct. 12.
The Economical Maintenance of Tracks and Roadways.* Martin Schreiber. (Abstract of paper read before the Amer. St. and Inter. Ry. Eng. Assoc.) (17) Oct. 12.
Report of Committee on Equipment. (Amer. St. & Interurban Ry. Eng. Assoc.)* John Lindall and others. (17) Oct. 13.
How to Run in Transition Curves without Tables.* (13) Oct. 13.
Three-Phase Traction in Italy; Some Practical Problems Encountered on the Three-Phase Giovi Line.* Warren H. Miller. (27) Oct. 13.
A New Railway in South Wales.* (12) Oct. 14.
Report of Committee on Heavy Electric Traction. (Amer. St. and Interurban Ry. Eng. Assoc.)* J. S. Doyle and others. (17) Oct. 14.
Lubrication of Car Bearings. (Abstract of report to the Mun. Tramways Assoc.) (47) Oct. 14.
The Rhaetian Railway.* (18) Oct. 15.
Urban and Interurban Terminals.* Martin Schreiber and F. F. Low. (Abstract of paper read before the Amer. St. & Interurban Ry. Eng. Assoc.) (17) Oct. 15.
Railway Signaling.* C. L. Hacket. (Paper read before the Central Ry. and Eng. Club.) (96) Oct. 20.
Car-Traversing Ballast Loader.* (15) Oct. 21.
The Copper River & Northwestern R. R.* (18) Oct. 22.
Storage Batteries for Railway Signal Service. (Report of Comm. to the Ry. Signal Assoc.) (18) Oct. 22.
The Track and Line Construction of Electric Railways. (13) Oct. 27.
Mountain Rack Railways and the Jungfrau Ry. (Switzerland).* E. L. Corthell, M. Am. Soc. C. E. (13) Oct. 27.
Quick-Dumping Drop-Bottom Steel Cars for Handling Iron Ore on the Michigan Iron Range.* (13) Oct. 27.
Schmidt's Smoke Tube Superheater for Locomotives.* (47) Oct. 28.

---

*Illustrated.

Railroads—(Continued).

Pacific Type Locomotive; Central Railroad of Brazil.* (15) Oct. 28; (18) Oct. 29.
Extensions and Betterments of the Great Northern Ry.* (18) Oct. 29.
Carrying a Street on Concrete Brackets. (From *Times Eng. Sup.*, London.) (14) Oct. 29.
Protecting Railroad Embankments against Currents. (14) Oct. 29.
Suburban Tank Locomotive 4-6-4 Type, Canadian Pacific Railway.* (25) Nov.
The Improved Baker-Pilliod Valve Gear.* (25) Nov.
Pacific and Consolidation Type Locomotives, Chicago, Milwaukee & St. Paul Railway.* (25) Nov.
Interesting Railway Achievements in New Zealand.* W. Wilson. (9) Nov.
The Electric Bolt Lock as Applied to Interlocking.* (Abstract from report of Comm. of the Ry. Signal Assoc.) (13) Nov. 3.
The First Judicial Decision in the Peoria Electrolysis Case. (14) Nov. 5.
Mallet Compound Locomotives for the Chesapeake & Ohio Ry.* (18) Nov. 5.
Screw Spikes and Specially Designed Tie Plates, Baltimore & Ohio and Long Island Roads.* (18) Nov. 5.
Overheating and Pressure Test of a Jacobs-Shupert Locomotive Firebox.* (13) Nov. 3.
The Logging Railways of the Pacific Northwest.* (15) Nov. 4.
Converted Mallet Locomotives for the Chicago Great Western.* (15) Nov. 4.
Locomotive Boilers. (25) Nov.
Mallet Articulated Compound Locomotive of the 2-8-8-2 Type (Virginian Ry.)* (25) Nov.
Résumé sur l'Organisation des Services Techniques d'un Réseau de Tramways Electriques. Fred Landolt. (34) Serial beginning Sept.
Locomotives à Marchandises, Compound, à Quatre Essieux Couplés et à Bogie, Compagnie des Chemins de Fer Paris à Lyon et à la Mediterranée.* (34) Oct.
Note sur l'Application des Enclenchements de Continuité à l'Electro-Sémaphore Lartigue.* Ch. Jullien. (38) Oct.
Note sur les Bogies de Voitures à Ressorts de Rappel à Lames Etagées de la Compagnie des Chemins de Fer du Midi. M. Bachellery. (38) Oct.
L'Elargissement du Goulot de Saint-Lazare, à Paris, Encorbellements de la Tranchée des Batignolles.* Charles Rabut. (33) Serial beginning Oct. 1.
Locomotive Electrique du Chemin de Fer de la Wengernalp (Suisse).* (33) Oct. 15.
Les Wagons-Ambulances des Chemins de Fer Fédéraux Suisses.* (33) Oct. 22.
Die Erweiterung des Bahnhofs Grunewald bei Berlin.* Blum und Giese. (49) Pt. 10.
D-Gleichstrom-Heissdampf-Güterzug-Lokomotive mit Rauchröhren-Uberhitzer von Schmidt und Zylindern mit Ventilsteuerung der Bauart Stumpf.* W. Wolters. (102) Serial beginning Oct. 1.
Ermittelung der Liegedauer der Eisenbahnschwelle.* E. Biedermann. (102) Serial beginning Oct. 1.
Wirkungen des Frostes auf das Eisenbahngleis. Schutzmassregeln dagegen.* Leo von Lubimoff. (102) Serial beginning Oct. 1.
Beitrag zur Berechnung von Lokomotiven.* Rud. Engel. (48) Oct. 22.

Railroads, Street.

Elevated Car Storage Yard.* (14) Oct. 15.
Itemized Unit Costs of 98 Special Overhead Layouts for a Trolley Railway.* (86) Oct. 19.
Street Railway Appraisal Methods at Chicago. (14) Oct. 29.
Design of Cars for Chicago Street Railways.* (17) Oct. 29.
Steel Guard for Paving Laid Against T-Rail.* (17) Oct. 29.
Chemical Treatment of Ties used in the Chicago Track Rehabilitation. (17) Oct. 29.
Cost of Concrete Work in Two Car Houses and a Substation for the Chicago City Railways Co. (86) Nov. 2; (17) Nov. 5.
Track Reconstruction on the Chicago Street Railways.* (13) Nov. 3.
Brooklyn Line Department, Manufacturing Facilities, Purchasing Standards and Experimental Work.* (17) Nov. 5.

Sanitation.

The Practical Questions Concerned in the Collection and Disposal of Municipal Waste.* William F. Morse. (Paper read before the Bost. Soc. of Civ. Engrs.) (1) Sept.
Effect of Sewage Gases on Concrete Work. Wm. Dunn. (67) Oct.
Cost of Sprinkling Filter Sewage Purification. (96) Oct. 13.
The Sterilization of Water and Sewage Effluents. H. C. H. Shenton. (96) Oct. 13.
First-Hand Impressions of German Sewage Disposal. H. N. Ogden, M. Am. Soc. C. E. (13) Oct. 13.

---

*Illustrated.

Sanitation—(Continued).

Drainage of Irrigated Lands with Special Reference to Experiments in Utah.* Charles F. Brown, Assoc. M. Am. Soc. C. E. (13) Oct. 13.
Expansion Tanks for Hot Water Heating.* (101) Oct. 15.
Sewage Disposal Works, Alliance, Ohio.* E. G. Bradbury, M. Am. Soc. C. E. (14) Oct. 15.
Sewage Purification Installation at Prescot, England. (96) Oct. 20.
Present Status of the Disposal of Sulphite Liquor in Germany. A. Pritzkow. (14) Oct. 22.
Reinforced Concrete Sewers in Soft Ground, Seattle.* (14) Oct. 22.
Diffusion and Digestion of Sewage in New York Harbor. (86) Oct. 26.
The Extraction and Collection of Dust in Manufacturing Operations.* (12) Oct. 28.
Heating in a Boston Bank Building.* (101) Oct. 29.
Sewage Disposal Works at Redditch, England. (Abstract of paper read before the Inst. of Mun. and County Engrs.) (14) Oct. 29.
The Disposal of Cheese Factory Waste. (From Annual Report, Ontario Bd. of Health.) (96) Nov. 3.
Twin Furnaces for Residence Heating.* (101) Nov. 5.

Structural.

Some Considerations on the Theories Governing the Elastic Breakdown of Members Subjected to a Compound System of Stresses.* A. S. C. Trench. (5) Jan.
Foundations for the Northwestern Railway Terminal Building, Chicago.* Maurice Deutsch. (6) Apr.
Machine *vs.* Hand-Mixed Concrete. C. W. Gaylord. (67) Oct.
A Method for Long Span, Light Floor; Reinforced Concrete Construction with Comparative Cost. Emile G. Perrot. (67) Oct.
Iron Castings: Defects and Remedies.* Robert Job. (Paper read before the Can. Ry. Club). (96) Oct. 13.
The Cracking and Partial Failure of Abutments and Retaining Walls.* Charles K. Mohler. (13) Oct. 13.
The Behavior of Hydraulic Compounds in Sea-Water.* H. Buchartz. (12) Oct. 14; (67) Oct.
Bending Moments in Concrete Wall Columns and Fixed Beams.* (14) Oct. 15.
Two Concrete Stairways.* (14) Oct. 22.
Deep Underpinning Through Sand.* (14) Oct. 22.
Method of Depositing Concrete by Chuting in a Seven-Story Building with Some Costs.* (86) Oct. 12; (14) Oct. 22.
Sheet Metal Construction of Pier Sheds.* (101) Oct. 29.
The Tacoma High School Stadium.* Leslie D. Howell. (14) Oct. 29.
A Large Reinforced Concrete Cantilever Girder.* (14) Oct. 29.
Fireproof Oilhouses.* (Report of a Comm. to the Amer. Ry. Bridge and Bldg. Assoc.) (18) Oct. 29.
Wire Glass in Roundhouses, Shops and Station Buildings.* (Report of a Comm. to the Amer. Ry. Bridge and Bldg. Assoc.) (18) Oct. 29.
The Permeability of Paint Films.* Henry A. Gardner. (3) Nov.
Methods and Costs of Excavating and Concreting a Swimming Pool.* (86) Nov. 2.
The Design of Retaining Walls, Adapted from Georg Christoph Mehrtens, "Vorlesungen Ueber Static der Baukonstructionen und Festigkeitslehre." George M. Purver. (86) Nov. 2.
Collapse of a Reinforced Concrete Grain Bin at Springfield, Ohio.* (13) Nov. 3.
Fire Protection of the Pennsylvania Station, New York City. (13) Nov. 3.
Creosoting Plant of the Pacific Creosoting Co., Eagle Harbor, Washington.* (13) Nov. 3.
A Reinforced-Concrete Cold Storage Warehouse at Jersey City, N. J.* Arthur G. Hoadley. (13) Nov. 3.
Construction Plant at the Minnesota Steel Works.* (14) Nov. 5.
Structural Details of the Curtis Buildings.* (14) Nov. 5.
Completion of Foundations for the Municipal Building, New York.* (14) Nov. 5.
The Maverick Cotton Mills at East Boston.* (14) Nov. 5.
Nouvelles Recherches Expérimentales de C. Bach et O. Graf. (relatives au béton et au ciment armé). (84) Sept.
Le Béton et la Céramique Armés; Système C. Poyet.* (84) Sept.
Le Béton non Armé.* N. de Tédesco. (84) Serial beginning Sept.
Nouveaux Essais au Choc à Températures Variables.* Léon Guillet et Louis Révillon. (93) Oct.
La Fatigue des Métaux et les Nouvelles Méthodes d'Essais.* Ch. Fremont. (33) Serial beginning Oct. 22.
Neubau der Königlichen Ansiedlungskommission.* Riepert. (49) Pt. 10.
Die Speicheranlagen im Hafen von Konstanza.* Buhle. (49) Pt. 10.
Uber Versuche mit Steinerhaltungsmitteln.* F. Rathgen. (49) Pt. 10.
Die neue Technische Hochschule in Breslau.* (49) Pt. 10.
Die Eisenbeton-Konstruktionen für die Aula der Schlesischen Blinden-Unterrichtsanstalt zu Breslau.* Karl Schaaf. (51) Sup. 20.

---

*Illustrated.

Structural—(Continued).

Flügelmauern aus Eisenbeton.* E. Elwitz. (78) Sept. 24.
Eisenbetonkonstruktionen am stadischen Friedhofneubau zu Frankfurt a. Main.* (78) Oct. 7.
Mosaik für Eisenbeton.* Edgar Bolhâr von Nordenkampf.* (78) Oct. 7.
Neuere feuersichere Türkonstruktion.* Wendt. (51) Oct. 8.
Berechnung vierseitig freiaufliegender rechteckiger Platten mit gleichmässig verteilter Belastung.* J. N. Dorner. (78) Oct. 27.
Feuersichere Wände aus Eisenbeton. R. Saliger. (78) Oct. 27.

Water Supply.

Fort William Water Supply.* H. Sydney Hancock, Jr. (5) Jan.
Some Recent Developments in the Purification of Public Water Supplies.* R. S. Lea. (5) Jan.
Filtration Works and Reservoirs for Portsmouth Water Supply.* (12) Oct. 7.
The Hydro-Electric Plant of the Cobalt Power Company at Hound Chute.* A. Vonaesch. (96) Oct. 13.
A Low-Head Hydroelectric Plant, Engineering and Economical Features of the Electric Generating Equipment at the University of Iowa.* Arthur H. Ford. (27) Oct. 13.
Flow Measurement by Means of the Pitot Tube.* (104) Oct. 14.
Derwent Valley Water Scheme.* (12) Oct. 14.
Tunneling Record on the Catskill Aqueduct. (14) Oct. 15.
Methods of Construction and Contractor's Plant on the Ashokan Reservoir, New York Water Supply.* (86) Oct. 19.
Cost of Water-Power and Coal. Alton D. Adams. (27) Oct. 20.
Concrete Tower Enclosing a Water-Works Tank at Gary, Ind.* (13) Oct. 20.
Excavation of Wallkill Pressure Tunnel, Catskill Aqueduct (New York City Water Supply).* G. Raymond Hulsart. (13) Oct. 20.
The Capital City Power Plant of the United Missouri River Power Co.* (13) Oct. 20.
A Hydroelectric Development on the Tajo River, Spain.* (14) Oct. 22.
Water Purification Plant at Richmond, Virginia. (14) Oct. 22.
The Green River Gravity Water Supply of Tacoma. Stuart Sims, Assoc. M. Am. Soc. C. E. (14) Oct. 22.
Enlargement of the Water Works of Portland, Ore. (14) Oct. 22.
The Infiltration Plant at Ironton, Ohio. (14) Oct. 22.
Labor Cost of Laying 16 Miles of 20-Inch Cast Iron Water Main at Cheyenne, Wyo.* M. V. Moulton. (86) Oct. 26.
Methods of Conducting Test Borings and of Sinking Shafts for the Hudson River Crossing of the Catskill Aqueduct.* (86) Oct. 26.
Water Powers. Herbert Knox Smith. (Paper read before the Natl. Conservation Cong.) (96) Oct. 27.
Pure Water and the Pollution of Waterways. Hodgetts. (Abstract of paper read before the Dominion Public Health Conference.) (96) Oct. 27.
Arched Masonry Dam at Las Vegas, N. M.* Charles W. Sherman, M. Am. Soc. C. E. (13) Oct. 27.
A Clever Question Regarding the Hypochlorite Process.* C. A. Jennings. (14) Oct. 29.
A Hydraulic Fill in the Turlock Irrigation District Canal.* A. Kempkey, Jr., Assoc. M. Am. Soc. C. E. (14) Oct. 29.
The Construction Plant for the Holter Dam.* (14) Oct. 29.
The First Judicial Decision in the Peoria Electrolysis Case. (14) Nov. 5.
The Esopus Cut-and-Cover Section of the Catskill Aqueduct.* (14) Nov. 5.
Der Talsperrenbau in Deutschland und Preussen.* Roloff. (49) Pt. 10.
Eisenbetonsiphon für eine Druckleitung unter 30 m Druckhöhe in Tuena, Spanien.* (78) Sept. 24.
Modellversuche über die Spannungsverteilung in massiven Sperrmauern.* Ziegler. (78) Serial beginning Oct. 7.
Amerikanische Wasserkraft-Uebertragungsanlagen.* Frank Koester. (48) Serial beginning Oct. 8.
Bestimmung von Stromrichtungen mit Pitotrohren.* Schuster. (From *Mitt. u. Forschungsarbeiten.*) (48) Oct. 8.

Waterways.

Subaqueous Concrete Works.* H. R. Lordly, M. Can. Soc. C. E. (5) Jan.
A Trip Across the Isthmus: Life and Conditions on the Canal Zone.* Martin Nixon-Miller. (2) Oct.
Percy's Patent Locomotive Stage. (For marine and river work.)* (96) Oct. 13.
Present Status of the Disposal of Sulphite Liquor in Germany. A. Pritzkow. (14) Oct. 22.
Methods of Constructing Cast Iron Culverts to Prevent Pulling Apart and of Repairing when Pulled Apart. (86) Oct. 26; (14) Oct. 22.

---

*Illustrated.

Waterways—(Continued).

A New Type of Dragline Scraper Excavator with Erection and Operating Costs.* (86) Oct. 26.

The Phenomena of the Sea, as Regards Encroachment and the Reclamation of the Coast.* Frank Latham, M. Inst. C. E. (Paper read before the Inst. of Mun. Engrs.) (104) Oct. 28.

The Use of the Rolling Dam in Europe.* (14) Oct. 29.

The Panama Canal.* G. H. Mee. (45) Nov.

Stream Measurements for the Dominion Government in Alberta, Sask.* Sauder. (Abtract of report to Supt. of Forestry.) (96) Serial beginning Nov. 3.

Methods of Bank Protection.* (Report of a Comm. to the Amer. Ry. Bridge and Bldg. Assoc.) (18) Nov. 5.

Le Projet de Canal de la Baie Georgienne (Canada).* G. Dupont. (33) Oct. 1.

Landungssteg aus Eisenbeton am Guadalquivir, Spanien.* Juan Manuel de Zafra. (78) Oct. 7.

Walzenwehr an der Trisanna.* Alfred Wessely. (53) Oct. 7.

Der neue Osthafen in Frankfurt a. M.* H. Uhlfelder. (51) Oct. 19.

Grundung des Arngast-Leuchtturmes bei Wilhelmshaven.* Carl Wesemann. (51) Oct. 22.

Die elektrische Treidelei der Wehranlage für die Unterweserkorrektion bei Bremen.* Otto Tuch. (48) Oct. 22.

---

*Illustrated.

Vol. XXXVI. NOVEMBER, 1910. No. 9.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

CONTENTS

Papers:

PAGE

Hydrography as an Aid to the Successful Operation of an Irrigation System.
By J. C. Stevens, Assoc. M. Am. Soc. C. E. 1320

Notes on the Bar Harbors at the Entrances to Coos Bay, and Umpqua and Siuslaw Rivers, Oregon.
By Morton L. Tower, M. Am. Soc. C. E. 1348

Timber Preservation, Its Development and Scope.
By Walter Buehler, M. Am. Soc. C. E. 1359

The Valuation of Public Service Corporation Property.
By Henry Earle Riggs, M. Am. Soc. C. E. 1369

Discussions:

The Arch Principle in Engineering and Esthetic Aspects, and its Application to Long Spans.
By Messrs. Max M. Miller, Leon S. Moisseiff, Fr. Engesser, and R. Krohn.. 1539

Memoirs :

Edmund Dorman Libby, M. Am. Soc. C. E. 1550
Thomas McKeown, M. Am. Soc. C. E 1551
John Jay McVean, M. Am. Soc. C. E. 1552
James Eager Willard, M. Am. Soc. C. E. 1553
Roger Brooke Irwin, Assoc. M. Am. Soc. C. E. 1556
Silas Gildersleeve Comfort, Assoc. Am. Soc. C. E. 1557

PLATES

Plate CLXXV. Map of Sunnyside Canal, and Diagram of Discharge Curve for 52-Mile Station, Sunnyside Canal, 1909 1327
Plate CLXXVI. Diagrams of Discharge Curves for Mathieson Lateral and 23-Mile Station, Sunnyside Canal 1333
Plate CLXXVII. Diagrams of Discharge Curves for 17-Mile Station and Zillah Wasteway, Sunnyside Canal 1335
Plate CLXXVIII. Harbors on the Oregon Coast 1353

Vol. XXXVI. NOVEMBER, 1910. No. 9.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

HYDROGRAPHY AS AN AID TO THE SUCCESSFUL OPERATION OF AN IRRIGATION SYSTEM.

By J. C. Stevens, Assoc. M. Am. Soc. C. E.

To be Presented December 7th, 1910.

The successful operation of a large irrigation project is a task that requires both engineering skill and business ability. The tendency toward larger projects is an inevitable one in the West; some of them now cover 300 sq. miles of territory, and include several goodly-sized cities within their boundaries.

Within these communities the highest type of agricultural development is to be found. Small holdings and intensive cultivation is the keynote of success, both from the standpoint of the management and of the agriculturist.

The time is not far off when the water used on these large systems will be distributed as carefully as under the metered systems of large cities, where patrons pay only for the water they use. In the absence, however, of a simple device for measuring the total quantity, the present method of delivering water at a continuous rate is the most practicable. Contracts for water usually specify a certain rate of flow per acre of land irrigated. This method is ineffectual, for obvious reasons, and becomes less effective as the size of the farm unit becomes smaller, but it is adopted because it simplifies operation. A simple

---

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

and inexpensive device to measure the total quantity flowing in an open channel as effectively as a meter measures that flowing in a pipe, is a great need; for such a device, if in general use, would overcome a hundred difficulties which are now almost insurmountable. On many projects, the practice of rotation is followed with excellent results, but the rate-measurement is still necessary.

Except in the larger canals and laterals, it is not likely that any device can supersede weirs; but in many such channels there is not sufficient fall to permit their use. The only other method available is that of the current meter.

During the seasons of 1908 and 1909 the writer made a hydrographic study of the Sunnyside Project of the United States Reclamation Service in Washington. The work in 1908 included seepage investigations on certain laterals of the system selected for that purpose; and in 1909 a similar study of the entire system was instituted, with plans for its continuance as an operation adjunct. As this work involved some interesting features of water measurement by current meter and weirs, a discussion of the hydrographic work as conducted on that project will doubtless be of interest to engineers engaged in irrigation practice.

General Description of the Sunnyside Project.

The Sunnyside Canal diverts water from the left bank of the Yakima River, in Sec. 28, T. 12 N., R. 19 E., Willamette Meridian. The canal system was purchased from the Washington Irrigation Company by the United States Reclamation Service in 1906. It then irrigated about 40 000 acres of land, and the plans of the Reclamation Service are for its ultimate enlargement to cover 90 000 acres. Active operation by the Government began in 1907.

The canal is now 60 miles in length, and parallels the Yakima River in its general direction. It irrigates practically all the land between the canal and the river, and has one lateral—Mabton Siphon—which crosses the river to lands on the south side. In all, about 47 000 acres of land were irrigated in 1909.

The soil of the valley is of volcanic ash, loam, sand, and clay, with occasional deposits of gravel. Near the lower extremity of the canal, lava rock is found, porous in texture, with occasional pockets or large voids.

Sandy volcanic ash makes an exceedingly productive soil, and some of the crop values reported are almost beyond belief. The better fruit lands lie along the upper portions of the canal and at the higher elevations in the lower portions. Diversified farming is the rule, and small holdings of from 10 to 40 acres predominate. In the favorable sections fruit is the leading crop, and in other parts large quantities of alfalfa are grown. The lands above the canal are covered with sage-brush, and their desert-like appearance presents a striking contrast to the well-kept orchards and green alfalfa fields below it.

The rainfall averages 7 in. per annum, a large portion of which occurs as snowfall during the winter.

The Operation Department is concerned with the distribution of the water, the maintenance of the system, the collection of rentals and fees, and the returning to the Reclamation fund of the cost of construction. For ease of operation, the main canal and the principal laterals are divided into beats. Each beat is in charge of a patrolman whose duty it is to inspect daily the condition of his portion of the main canal, to regulate the headgates for the diversion of the water from the main canal to the laterals, and for the delivery of water to individual tracts.

Mile-posts have been placed throughout the entire length of the main arteries, and place-designations are made by numbers corresponding to their distance in miles from the intake. At convenient points telephone booths have been erected, and the entire system is connected by telephone with the manager's office.

Gauging stations are established at the extremities of each beat, where the discharge is measured. At all points of diversion from the main arteries, there are weirs or other measuring devices in the laterals, with gauges to indicate the head of water. Readings of gauge heights at gauging stations, and of the head of water on weirs in diverting laterals, are made each morning by the patrolmen, who report them by telephone to the manager's office, where a receiving clerk records them on suitable forms. The patrolman's report card is forwarded to the office after the Saturday report, where the reports received by telephone are checked against the original records.

The collecting of these records is in charge of a field engineer or hydrographer, who also makes the necessary current-meter measurements, and computes and analyzes the data as they accrue. He also makes daily, weekly, and monthly reports to the manager, showing the quantity of water received at the intake, the quantity diverted into laterals for irrigation, and the quantity wasted and lost. These reports are used by the manager and superintendent for regulating the water throughout the entire system, in order to meet the ever-changing requirements.

In 1909 the division of the canal system into beats was made without consulting the Hydrographic Division, since operation requirements governed the selection, rather than ease of determining flow. The hydrographer, therefore, was required to determine discharges at certain designated points without regard to obstructions or poor gauging conditions which might be encountered.

Table 1 gives the subdivisions for 1909, and the manner in which the stations are designated. For convenience, the gauging stations are given names corresponding to the nearest even mile number. The number and kind of measuring devices at the head of diverting laterals is also given.

TABLE 1.—SUBDIVISIONS OF SUNNYSIDE CANAL SYSTEM, FOR OPERATION REQUIREMENTS, IN 1909.

Number of beat.	Extends: From:	Extends: To:	Number and kind of diversions.
		MAIN CANAL.	
1	Intake	8.03-Mile	28 " Konnewocks."*
2	8.03-Mile	17.00-Mile	19 " Konnewocks."* 27 1-ft. Weirs. 6 2-ft. Weirs. 2 3-ft. Weirs. Zillah Waste-way.
3	17.00-Mile	22.90-Mile	12 1-ft. Weirs. 3 2-ft. Weirs. 8 3-ft. Weirs. 1 6-ft. Weir.
4	22.90-Mile	27.60-Mile	5 1-ft. Weirs. 3 2-ft. Weirs. 2 3-ft. Weirs. 1 5-ft. Weir. 1 6-ft. Weir.
5	27.60-Mile	30.34-Mile	6 1-ft. Weirs. 6 2-ft. Weirs. 3 3-ft. Weirs. 2 4-ft. Weirs. 2 5-ft. Weirs. 2 6-ft. Weirs.
6	30.34-Mile	32.27-Mile	4 1-ft. Weirs. 1 2-ft. Weir. 3 3-ft. Weirs. Snipe's Mountain Lateral.

* A description of " Konnewocks " is given on p. 1325.

TABLE 1.—*Continued.*

Number of beat.	Extends:		Number and kind of diversions:
	From:	To:	
	SNIPE'S MOUNTAIN LATERAL.		
S — 1	Intake	6-Mile	16 1-ft. Weirs. 4 2-ft. Weirs. 1 3-ft. Weir. Turner Lateral.
S — 2	6-Mile	9-Mile	14 1-ft. Weirs. 4 2-ft. Weirs. 1 5-ft. Weir. 1 8-ft. Weir.
	ROCKY FORD LATERAL.		
R — 1	Intake	3-Mile	4 1-ft. Weirs. 1 2-ft. Weir. 1 8-ft. Weir.
	MAIN CANAL.		
7	32.27-Mile	37.77-Mile	2 1-ft. Weirs. 11 2-ft. Weirs. 3 3-ft. Weirs. 1 4-ft. Weir. 1 6-ft. Weir. 2 1-ft. Weirs.
8	37.77-Mile	42.63-Mile	4 1-ft. Weirs. 10 2-ft. Weirs. 3 4-ft. Weirs. 1 5-ft. Weir.
9	42.63-Mile	48.31-Mile	2 1-ft. Weirs. 8 2-ft. Weirs. 2 3-ft. Weirs. 1 6-ft. Weir. 1 12-ft. Weir.
10	48.31-Mile	52.05-Mile	3 1-ft. Weirs. 5 2-ft. Weirs. 3 4-ft. Weirs. 1 6-ft. Weir. 1 12-ft. Weir. Mathieson Lateral.
11	52.05-Mile	55.73-Mile	6 1-ft. Weirs. 2 2-ft. Weirs. 1 4-ft. Weir. 2 6-ft. Weirs.
12	55.73-Mile	59.47-Mile	4 1-ft. Weirs. 3 2-ft. Weirs. 1 3-ft. Weir. 2 4-ft. Weirs. 1 6-ft. Weir.

Between the intake and the 17-Mile station on the main canal there are a great many miner's-inch modules. All deliveries in Beat 1 and about half the deliveries in Beat 2 are provided with these modules. They consist of an elongated orifice, 2 in. high, with a slide by which the length of the orifice can be varied. There is a long spillway which purports to keep the water at a head of 6 in. over the top of the orifice. They are crude structures, and are very indifferent measuring devices, but their use is required by the terms of a contract with the old Konnewock Irrigation Company which installed them. From this fact they are called "Konnewocks."

Trapezoidal weirs are maintained at other delivery points. They consist essentially of a weir board cut to the proper form and covered with a ready-made strip of galvanized iron bent and soldered to shape.*

On Plate CLXXV there is a condensed map of the entire canal system showing the manner in which it is subdivided and the location of all gauging stations maintained during the season of 1909.

CANAL HYDROGRAPHY.

The desire for greater efficiency in operation led to the adoption of a hydrographic division as a part of the Operation Department of the Sunnyside Project. It was soon realized that conservative distribution could not be obtained without a systematic and exhaustive study of the disposition of all waters diverted into the canal, the object being to determine as nearly as possible the relative quantities actually used on agricultural lands, wasted in operation, and lost by seepage and evaporation.

The first steps were necessarily experimental, for the scheme opened up somewhat new phases of hydrographic work. The chief difference consists in the fact that a much higher degree of accuracy is required than is considered necessary in ordinary river hydrography. The truth of this will be at once recognized after considering the ultimate aim of the two lines of work.

In river hydrography the aim is to determine the flow at desired points in order that the future behavior of streams may be predicted, the assumption being that past behavior is a fair indication of future conditions.

These data form a basis for the design of structures, and for determining the feasibility of proposed projects. In general, if results on rivers are secured within 10% of the actual flows they are sufficiently accurate for practical purposes, for it would not be wise to go to the expense of securing ultra-refined results on rivers when it is known that past behaviors are only approximate indications of the future. Other uses for river data, of course, create exceptions to this general statement.

---

* A description and calibration of the Sunnyside type of weir may be found in *Engineering News*, August 18th, 1910.

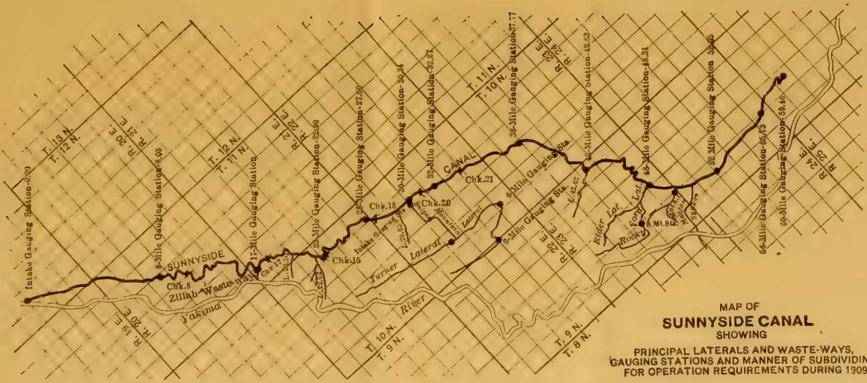
In canal hydrography, however, an entirely different perspective must be taken. The flow is always under artificial regulation. Unnecessary wastes are at once detected, and changes for betterment, either in structures or methods of delivery, can be adopted, with actual data as a basis. The diversion of more water than is required for the system unnecessarily deprives other canals, below or above, of water that could be used beneficially elsewhere. From the operation standpoint, in connection with the "human problems" encountered, it is highly important to know at all times how much water is being delivered to every farm unit of the system. In short, if systematic hydrographic work is carried on, in conjunction with the operation of any canal system, the officers know the conditions at all times; if not, they work blindly.

A little reflection will reveal the exacting nature of these investigations, if consistent results are obtained. The hydrographic division is frequently concerned with differences of 1 sec-ft. or less in 500 or more. It is impossible, of course, to secure as accurate results as this, yet they are useless unless they possess a degree of accuracy considerably beyond that heretofore conceded possible in ordinary field hydrography. The present methods cannot be discarded, but they can be refined and adapted to the exigencies of the case.

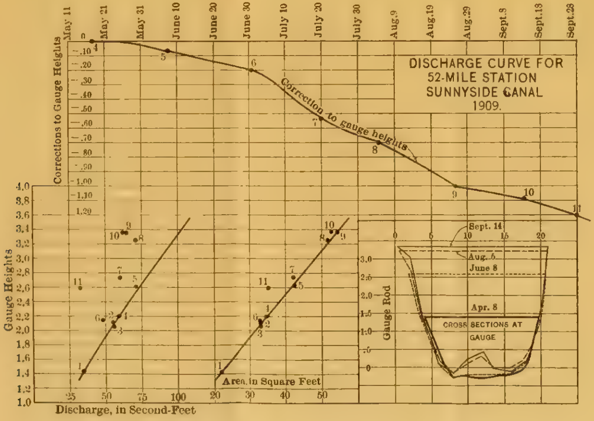
Sources of error, which in ordinary river work could be overlooked, must be eliminated as far as possible, or the results secured will not fulfill the purposes for which they are intended. Some of the physical difficulties encountered on the Sunnyside Project and the methods used to overcome them will be more or less applicable to all large irrigation systems.

Gauge heights, heretofore, have been used in all hydrographic work as a basis for determining the daily flow. From measurements of discharge by current meter at various stages a discharge curve is developed to which intermediate gauge heights are applied. Strictly speaking, gauge heights are an index of area only. Under permanent conditions of bed and banks, or when indicative of the head over some controlling obstruction, as a rocky ledge or a weir, gauge heights

PLATE CLXXV.
PAPERS, AM. SOC. C. E.
NOVEMBER, 1910.
STEVENS ON
HYDROGRAPHY AS AN AID IN IRRIGATION.



MAP OF
SUNNYSIDE CANAL
SHOWING
PRINCIPAL LATERALS AND WASTE-WAYS,
GAUGING STATIONS AND MANNER OF SUBDIVIDING
FOR OPERATION REQUIREMENTS DURING 1909



DISCHARGE CURVE FOR
52-MILE STATION
SUNNYSIDE CANAL
1909.

are a fair indication of discharge. These conditions, however, seldom exist in earth sections.

The water in most irrigation canals carries large quantities of silt. This causes continual changes in the bed and banks, and consequently the gradient of the canal. Tumble-weeds and thistles are a source of endless trouble. They roll into the canal, are carried along by the current until they encounter an obstruction or become water-logged, or weighted with silt, and sink to the bottom. There they form the nucleus of an obstruction which continually enlarges, backing up the water until the increased pressure and currents carry them away. Such back-water effects are relatively small, but by no means negligible; yet their effect is indeterminate, and no corrections can be applied for them.

Wherever the velocity is retarded, the canals gradually silt up as the season advances, so that a gradually increasing back-water effect is encountered. In many places the growth of weeds and moss in the canal and along the banks produce the same back-water effect. Sweet clover is particularly troublesome. It grows luxuriantly along the banks, and, as the tops bend over and trail in the water, they soon become heavy with silt and seriously obstruct the channel. Such back-water effects are progressive with the season, and corrections are readily applied if a sufficient number of discharge measurements are made. For these reasons, gauge readings as reported are not an index of discharge, and only become so after corrections for these effects have been applied to them.

Gauge heights and the head on weirs are read and reported once a day. A single reading indicates only the rate of flow at the time of observation, and it is necessary to assume that this rate obtains for the entire 24 hours. This assumption, it will be shown, may lead to errors which are sometimes cumulative instead of compensating, as might be expected.

The delivery of water usually begins about April 1st, and as the season advances, the head of water in the canal is gradually increased to the maximum requirement, which occurs about the middle of August. Crop requirements are variable, and these variations are largely taken care of at the waste-ways.

The operation of checks for keeping the water to levels required for delivery usually proves to be one of the most serious difficulties. These checks are so numerous in the first 30 miles of the Sunnyside Canal that it is almost impossible to select a point for a gauging station which is not influenced by one of them. The difficulty arises from the variable back-water they cause.

If it were not for the weeds and trash, which, in spite of all precautions, will find their way into the canal and accumulate at these checks, no serious difficulty would be encountered at gauging stations within their influence, although the data to be gathered and analyzed, in order to correct for the back-water they cause, greatly increase the labor of computations. This accumulation of trash, and its subsequent removal, renders the control they exert on the flow an irregularly variable quantity. If this were not the case, the control would vary with some degree of regularity, and due allowances could be made.

Such severe conditions, of course, are seldom if ever met in river hydrography, and it is on river requirements that the present hydrographic methods have been developed. It is true that in canals there is not a great range of stage with which to contend, yet the conditions within these stage limits are far more intricate than are encountered in river work, and require special treatment.

METHODS ADOPTED ON THE SUNNYSIDE PROJECT.

The methods followed on the Sunnyside Project will be generally applicable to all cases where results of a fairly high degree of accuracy are required. The plan followed is by no means perfect, neither were the results secured as accurate as might be desired; however, they were sufficient for the immediate requirements, and marked a decided advance over ordinary river hydrography.

In general, the methods were those at present practiced by the Water Resources Branch of the U. S. Geological Survey, except that each detail was carried to a greater degree of refinement.

Current-Meter Measurements.—The current-meter measurements were all made with the improved Small Price Penta-Meter, which indicates every fifth revolution of the wheel. The meter, at all except the shallow-water stations, was suspended on a single steel wire in order to reduce oscillations. A ground circuit completed the electrical connection with the telephone indicator.*

---

* "The Use and Care of the Current Meter, as Practiced by the United States Geological Survey," by John C. Hoyt, M. Am. Soc. C. E., *Transactions*, Am. Soc. C. E., Vol. LXVI, p. 70.

Velocity observations were taken at two-tenths and eight-tenths of the depth, and the average velocity thus determined was taken as the mean velocity in the vertical. This method has proved to be the most reliable for general field practice, where depth of water will permit. In depths less than about 1 ft. the six-tenths method of determining velocity was used. Observations were taken at intervals not greater than 2 ft. across the stream.

As indicative of the accuracy of individual gaugings obtained in this manner, Table 2 shows comparative results of a series of measurements made simultaneously at some of the gauging stations. They were made for the purpose of comparing a Penta-Meter with a "Single Point" Meter.

TABLE 2.—COMPARISON OF METERS AND METER MEASUREMENTS MADE JUNE 25TH TO 28TH, 1909.

Station.	Meter.	Area.	Discharge.	DIFFERENCE:	
				Second-feet.	Percentage.
Intake...........	P 745	216	634	8	1.3
Intake...........	S 134	216	642		
8-Mile...........	P 745	237	620	9	1.4
8-Mile...........	S 134	237	611		
23-Mile...........	P 745	214	469	0	0
23-Mile...........	S 134	214	469		
28-Mile...........	P 745	209	466	3	0.6
28-Mile...........	S 134	209	469		
30-Mile...........	P 745	151	332	6	1.8
30-Mile...........	S 134	151	326		
32-Mile...........	P 745	143	323	3	0.9
32-Mile...........	S 134	143	326		

Gauges.—Several types of staff gauges have been tried. One graduated directly to hundredths of a foot by fine saw marks was found to be the best. The graduations are made on a clear piece of 1 by 3-in. board. For a space of 1 in. along one edge, the face of the board is slightly beveled, and the hundredth marks are first laid off in pencil on this beveled portion, and then sawed in a miter box. The tenth and foot marks are made in the same manner on that portion of the face which is not beveled. The figures are stenciled in black paint.

In placing gauges, an arbitrary datum was used at each station, the only precaution being to place the gauge low enough to avoid negative gauge heights.

The gauges for reading the head of water on the weirs were made in 1-ft. and 2-ft. lengths. The graduations were in inches and eighths. Each was placed with its zero level with the crest of the weir. It is the intention to replace all weir gauges with a better type, reading to hundredths of a foot, but the water users under the old management had become accustomed to weir-heads measured in inches and the patrolmen's tables for individual allowances were in these units. For the sake of uniformity, therefore, the same units were used at diversions.

Four Lietz self-registering gauges were placed at favorable points along the main canal, in order to determine the extent of fluctuations and the error involved in using a single gauge reading for ascertaining daily discharge. They were placed respectively at the Intake, the 17-Mile, 28-Mile, and 42-Mile gauging stations. The staff gauges at these stations were reported the same as at all other stations, irrespective of the Lietz gauges. Some difficulty was encountered at first in keeping them running. The stylo-pens furnished by the manufacturers were found to be worthless, and not until soft pencils were substituted and the patrolmen became familiar with the peculiarities of the gauges were good results obtained.

The daily discharges at each of these stations have been computed, from the patrolmen's records of single daily gauge heights, and also by using the mean daily gauge heights taken from the Lietz record sheets. The results are compared in Table 3.

From Table 3 it is seen that, taken by months, the errors of determining the discharge from single daily observations of gauge heights are compensating. In no case was the mean monthly discharge in error greater than one-half of 1% ; but, in order to show how these errors may for certain periods tend to accumulate, Table 4 has been prepared for periods when the general change of stage was all in one direction. From this it is seen that even these are small, rarely exceeding 2 per cent. In general, the error should be positive for a falling stage and negative for a rising stage. This general tendency, however, cannot be detected when the stage is changing slowly and other complicating factors enter.

Computations.—Discharge curves were prepared in the usual manner,* and daily discharges were taken from rating tables made from the discharge curves. As soon as two or three measurements

---

* The methods used by the U. S. Geological Survey are described in the introduction to any one of Water Supply Papers, Nos. 201 to 214, or 241 to 252.

TABLE 3.—COMPARISON OF DISCHARGES, OBTAINED FROM SINGLE DAILY OBSERVATIONS, AND FROM LIETZ AUTOMATIC GAUGES.

Month.	MEAN MONTHLY DISCHARGES, IN SECOND-FEET:		DIFFERENCE:	
	Single daily observation.	Mean daily from automatic gauge sheets.	Second-feet.	Percentage.
		INTAKE STATION.		
May	611	609	2	0.3
June	618	620	2	0.3
July	662	665	3	0.5
August	686	685	1	0.2
September	617	616	1	0.2
		17-MILE STATION.		
May	540	545	5	0.9
June	526	527	1	0.2
July	603	600	3	0.5
August	585	585	0	...
September	508	507	1	0.2
		28-MILE STATION.		
May	477	476	1	0.2
June	474	474	0	...
July	520	520	0	...
August	511	512	1	0.2
September	465	464	1	0.2
		42-MILE STATION.		
May	202	203	1	0.5
June	220	219	1	0.5
July	228	227	1	0.5
August	238	238	0	...
September	235	235	0	...

TABLE 4.—ACCUMULATIVE ERRORS CAUSED BY USING SINGLE DAILY OBSERVATIONS FOR DETERMINING DAILY DISCHARGE.

Station.	Period.	MEAN DISCHARGE FOR PERIOD:		DIFFERENCE:	
		By single daily observation.	By automatic records.	Second-feet.	Percentage.
Intake	May 3d to 12th,	602	597	5	0.8
	June 22d to July 5th.	627	634	7	1.1
17-Mile	July 26th to August 2d,	591	585	6	1.0
	August 10th to 14th.	578	588	10	1.7
28-Mile	July 2d to 7th,	508	503	5	1.0
	September 16th to 22d.	397	402	5	1.2
42-Mile	May 6th to 10th.	194	197	3	1.5

were taken at any one station a provisional rating was made. This was revised from time to time as more data were secured. At the close of the season the entire field was reviewed, and new ratings were prepared, using the entire season's data, and all discharges were tabulated anew.

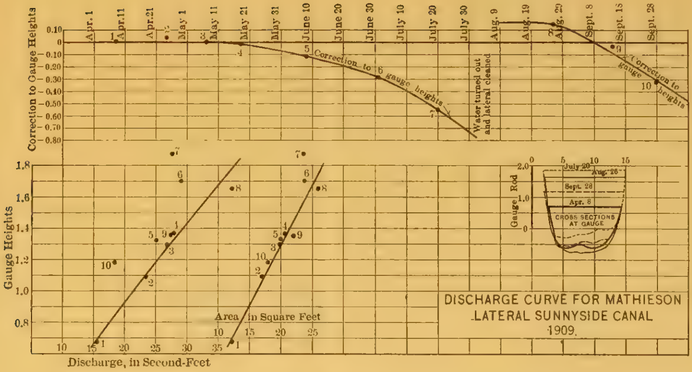
At only four stations was it possible to use the rating tables directly. At all other stations indirect methods had to be followed. This was due to silting, or the growth of weeds, causing back-water effects. Where these changes are progressive, the indirect method will give as good results as the direct, if a sufficient number of measurements are taken to define the correction curve.

Stout's indirect method* was the one followed. This was first used by O. V. P. Stout, Professor of Civil Engineering, University of Nebraska, to determine daily discharges in streams with shifting sandy beds. In effect it reduces the labor otherwise involved in the use of a number of rating tables, each applicable for a short period, and smooths the transition from one to the other. A rating table is prepared which gives, as nearly as possible, the relation between gauge heights and discharge if there were no changes in the rating. Then corrections are applied to the gauge heights before applying them to the table. The corrections are read from a correction curve in which the times are the abscissas and the differences between this rating table and the measured discharges are the ordinates.

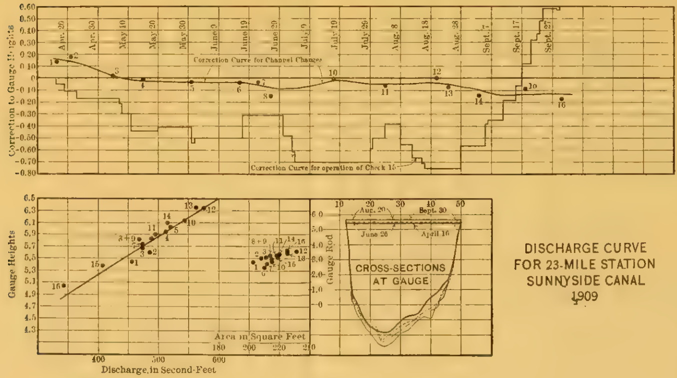
The discharge and correction curves for the 52-Mile station on the Main Canal are shown on Plate CLXXV, and those for the Mathieson Lateral on Plate CLXXVI. At the 52-Mile station the corrections were made on account of back-water caused by the growth of weeds. Changes in the bed at the gauging sections also occurred, as will be seen from the cross-sections and area curves. In the Mathieson Lateral there was back-water, both from the silting up of the channel and the growth of weeds. The water was shut off from August 1st to 7th, and the lateral cleaned, which caused the sudden break in the correction curve. At both these stations the changes were progressive, and the results are nearly as reliable as if the direct method had been used. The conditions encountered and the methods used at certain gauging stations deserve special mention.

---

* Water Supply Paper No. 230, p. 10 *et seq.*



DISCHARGE CURVE FOR MATHIESON LATERAL SUNNYSIDE CANAL 1909



DISCHARGE CURVE
FOR 23-MILE STATION
SUNNYSIDE CANAL
1909

23-Mile Station.—The conditions at the 23-Mile station were very complicated. Two sets of corrections were made, one for the backwater effect due to the operations of Check No. 15, located 2 000 ft. below the station, and the other for changes in the channel. A record was kept by the patrolman, on a card especially prepared for that purpose, of every alteration in the check and the effect it produced on the gauge at the gauging station. The gauge at the station was read immediately before each alteration and as soon after as the new condition of flow had become permanently established. This gave the effect on the gauge of altering the check, and these effects were algebraically added throughout the season.

The time between altering the check and observing the gauge at the station was dependent on the time at the disposal of the patrolmen. Sometimes an insufficient time was allowed and at others the time was so great that the actual flow in the canal may have changed. Hence, as to the alterations in the check alone, it was not always possible to determine their effect on the gauge at the station without including the effect of some other factor. However, the results were quite satisfactory considering the conditions under which they were obtained.

The lower half of Plate CLXXVI shows the essential features involved in computing the discharge at the 23-Mile station, as follows:

(1) The area of cross-section at the time of making the gaugings, plotted with the observed gauge heights. This shows how the water was kept at the same general level throughout the season.

(2) The algebraic sum of the corrections caused by check operations, producing the "correction curve for operations of Check 15."

(3) Discharge measurements plotted with gauge heights after correcting them for check operations, and the rating curve adopted.

(4) The cross-sections at representative times throughout the season.

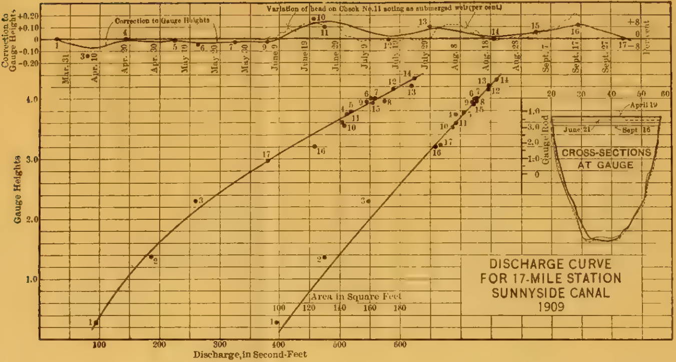
(5) The correction curve for channel changes. These corrections were applied to the gauge heights previously corrected for check operations, before applying them to the rating table.

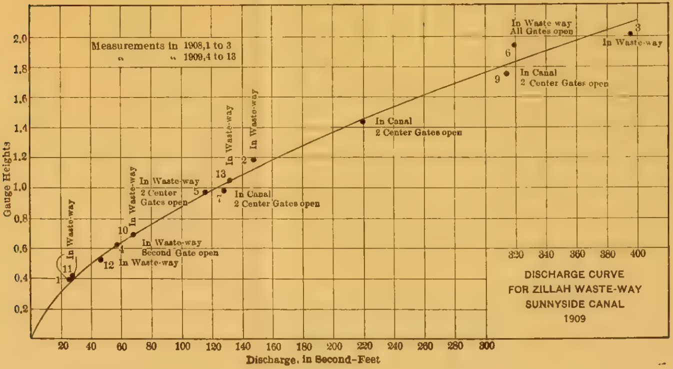
17-Mile Station.—At this station the change in rating is due to variable entrance velocities, the effect being very pronounced because the station is near the point of disturbance.

In line with the up-stream abutment to the waste-gates in the Zillah Waste-way there is a seven-panel check across the main canal. The 17-Mile station is 200 ft. below these combined structures. The flow in the canal below this check is regulated by the waste-way. The water on the up-stream side of the check was gradually raised throughout the season. On the lower side of the check the elevation of the water surface varied as the water was wasted. These fluctuations caused a changeable head on the submerged discharge area through the check, its action being that of a submerged weir. This created wide variations in the velocity of retreat which immediately becomes velocity of approach at the gauging station. In fact, these effects are analogous to the velocity of approach effect on weir discharge, the exact effect on the discharge being dependent on the distribution of velocities in the section of the gauge.

No data were obtained from which the actual head of water on the submerged portion of the check could be computed, but, by expressing the difference between the gauge readings at the 8-Mile and 17-Mile stations as a percentage, although the relations of the gauge datum are unknown, the relative variations in the head can be shown. This has been computed for each day from June 1st to September 15th, and the curve thus obtained is compared with the correction curve used at the 17-Mile station on Plate CLXXVII. Note the general parallelism of the two curves. If specific data as to the variations in head on this check had been obtained, and the time of gauging the 17-Mile station had been selected with reference thereto, a much closer agreement could doubtless have been obtained; but this effect was not recognized until too late in the season to gather the necessary data. On this account, the indirect method has been applied in the usual manner.

Zillah Waste-way.—The Zillah Waste-way diverts water from the main canal just above the 17-Mile station. The first 800 ft. is an open concrete section, trapezoidal in form, which gradually decreases in bottom width and increases in slope. The station is located in a straight stretch, 200 ft. below the gates, where the bottom width is 9 ft., the side slopes are 1 : 1, and the gradient 0.003. A hook-gauge was placed in a stilling-box set outside the concrete lining and connected


DISCHARGE CURVE
FOR 17-MILE STATION
SUNNYSIDE CANAL
1909


DISCHARGE CURVE
FOR ZILLAH WASTE-WAY
SUNNYSIDE CANAL
1909

by a $\frac{1}{4}$-in. pipe, 6 ft. long, ending flush with the side and as near the bottom as possible. Variable velocities and great wave action may result, depending on the gate combinations used in diverting the water, so that the gauge heights are only an approximate index of the discharge. A record was kept of the gate openings and of the head of water on the openings, but they were found to be valueless for determining the flow on account of trash accumulations at the gates. Therefore, the direct method was used. The discharge curve for this station is shown on Plate CLXXVII. Some idea is also given of the differences in gauge height for the same discharge which may result from different combinations of gate openings. Some of the discharges were obtained by direct measurement in the waste-way and some by measuring the main canal above and below the waste-way. Velocities as high as 21 ft. per sec. were measured with a current meter at this station.

Weirs.—Nearly all water diverted from the main canal was passed over trapezoidal weirs. The errors resulting from their use are very difficult to determine. Crop requirements are variable, and this necessitates continual adjustments of head-gates. The practice among patrolmen was to make adjustments of head-gates immediately after recording the head on the weir. It was impossible to have these adjustments made simultaneously over the entire system.

To measure properly, weirs must be kept in good repair, and the required conditions as to fall, contractions, etc., must be maintained. This is very difficult of accomplishment in practice. Newly placed weirs soon silt up, so that bottom contraction and sometimes end contractions are wholly or partially suppressed. Frequently the lateral below silts up or is so choked with weeds that water is backed over the crest of the weir. The eternal vigilance necessary to have kept all weirs in good order would have required the employment of a crew of laborers especially for that purpose. The patrolmen, however, were required to keep them cleaned at the headings as far as possible. In the distribution system, the burden of keeping weirs clean devolves on the individual water user. He rarely acts, however, until conditions are so bad that he cannot get sufficient water. This type of weir was calibrated by volumetric tests made in 1908.* These tests gave rating tables differing considerably from the Cippoletti formula. The diversions in Beat 3 for April have been computed by the Cippoletti formula and also by the revised rating tables. The Cippoletti weir formula gives 29.61 sec-ft. for the average daily diversion, while the revised tables give 30.83 sec-ft., or 4% more. This difference is small, but is not negligible from the standpoint of distribution, for nearly all water delivered is ultimately measured over small weirs, there being more than 5 000 in use on the system.

---

* A description of these weirs, and the results of the experiments, may be found in *Engineering News*, August 18th, 1910.

Cost.

Careful records of the costs of the hydrographic work were kept on this project, and are summarized in Table 5. They do not include the services of a recording clerk nor the time spent by patrolmen in taking gauge readings. These men were regular employees of the Operation Department, and had many duties not connected with the hydrographic work. Otherwise these costs include all field work during the irrigating season, current analysis and reports, and the cost of the final analysis and report after the season closed.

TABLE 5.—Cost of Hydrographic Work on the Sunnyside Project, 1909.

	Amount.	Percentage of total.
Services, field	$506.61	23
Computations	763.32	35
Administration	321.42	15
Lost time (Sundays, holidays, annual leave, etc.)	201.42	9
Traveling expenses	272.16	13
Supplies and equipment	110.10	5
Total	$2 175.03	100

Number of gauging stations maintained	23
Cost per station	$94.50
Number of gaugings made	266
Cost per gauging	$8.18

Application to Operation Requirements.

In order to make the data secured of the greatest use in operation, it is necessary that the results be worked up as rapidly as they accrue. If the direct method of applying daily gauge readings to discharge curves could be used throughout, this requirement could easily be met; but, for stations in earth sections and within the influence of checks and other disturbing factors, some indirect method must be used, as long as gauge heights alone are depended on as an index of discharge. Discharge measurements must be made at frequent intervals and at critical times. It is obviously impossible to determine the proper corrections to be applied to gauge heights on any one day until the measurement at the end of that time interval has been made. To make a meter measurement every day at each station is out of the question. The period which may safely be allowed between times of gaugings will depend on the stability of conditions at that station; but, in general, from ten to fifteen days may be regarded as the limit.

In preparing discharge data for current uses, the only method that can be followed is to estimate from known conditions and the corrections indicated by the gauging last made, what corrections to gauge heights are necessary. This will enable the hydrographer to prepare daily reports showing approximately the disposition of water in the system. At the end of the week or month it is possible to revise the rating tables and correction curves, and approximate the truth more closely. At the end of the season all tabulations are made anew, and final adjustments permit the elimination of all errors as far as possible. The labor involved in this process is great, for the estimates for some stations may require revision ten or more times. However, a little practice, and the adoption of some short-cut methods, enabled the hydrographer with one clerical assistant to keep the computations up to date.

For daily requirements approximate results are sufficient, because they are used chiefly for the distribution of water in the main channels day by day. The weekly and monthly reports are revisions, and serve for a broader study of distribution to certain areas or to certain crops. The final seasonal report furnishes data whereby the general efficiency of the season's operation can be studied. The lessons learned from one season's operation are thus utilized in planning the next season's work.

Under the Sunnyside Project, sufficient data on crop statistics and crop requirements had not been secured previous to 1909 to render the discharge data of the highest possible use. The acreage irrigated varies day by day and month by month and this variation should be known in order to operate the system efficiently. The acreage in the various crops had not been secured except in a very general way. It takes a great deal of time to gather all these statistics and to keep them up to date. On this project steps are being taken to gather very complete data of this nature, but they are not available for study in connection with the discharge data secured in 1909. On this account, only general lessons can be drawn from that season's operation.

Table 6 shows the monthly and seasonal disposition of all water received at the intake. The unit is the acre-foot. It also shows the quantity wasted through operation and the quantity delivered to the water users. The latter is an approximation, and includes the error of estimating the seepage losses in the distributing laterals.

TABLE 6.—SEASONAL DISPOSITION OF WATER RECEIVED AT THE INTAKE OF SUNNYSIDE CANAL IN 1909.

	April 16th to 30th.	May.	June.	July.	August.	September 1st to 15th.	Total.
Water received at intake, in acre-feet	17 190	37 400	36 830	40 820	42 060	18 300	192 600
Wasted in operation, in acre-feet.............	907	655	2 416	915	2 101	1 077	8 070
Wasted in operation: percentage...........	5.3	1.8	6.6	2.2	5.0	5.9	4.2
Losses from main canal (seepage, etc.), in acre-feet..............	2 776	5 643	5 015	7 453	8 324	3 441	32 650
Losses from main canal: percentage	16.1	15.1	13.6	18.2	19.8	18.8	16.9
Diverted into distributing laterals, in acre-feet..................	13 640	31 130	29 380	22 240	31 670	13 830	151 900
Diverted into distributing laterals: percentage....	79	83	80	79	75	76	79
Estimated loss in distributing laterals, in acre-feet*............	1 857	4 148	4 017	4 358	4 324	2 093	20 800
Net amount used on lands, in acre-feet ...	11 780	26 990	25 360	27 890	27 340	11 740	131 100
Net amount used on lands: percentage...	67	72	69	71	65	64	68
Acres irrigated	....	....	....	....	....	....	47 000
Depth of water applied, in feet...............	....	....	....	....	....	....	2.79
Rainfall, in feet........	0.001	0.015	0.016	0.043	0	0.002	0.077
Total depth received by the land, in feet...							2.87

* Loss in distributing laterals assumed as follows:
5%, intake to 17-Mile; 10%, 17 to 30-Mile; 15%, 30 to 52-Mile; 25%, below 52-Mile. These values follow from the investigations of seepage made in 1908 on certain laterals chosen for that purpose.

Table 6 is worthy of study. It shows that 68% of the water diverted from the Yakima River was delivered to water users and that 28% was lost by seepage, of which 17% applies to the main canal and 11% (estimated) to the distributing laterals. This, of course, is not "seepage" in the strict sense of the word, for it includes evaporation and the uncompensated errors of observation and measurement. In regulation, 4% was wasted.

The percentage of water diverted into the distributing laterals by months is a fairly good measure of the efficiency of the system. This had its maximum value of 83% in May. During this month the canal is free from weeds, all weirs are in good measuring condition, and the head in the canal is not excessive. August is the least efficient month, for the canal is crowded to its maximum capacity to supply the demand for water, the carrying capacity of the laterals is relatively low, and the losses are consequently high.

Table 6 also indicates that the lands under the canal received water equivalent to a total depth of 2.87 ft. during the season of 5 months. This figure is obtained by dividing the total quantity of water delivered to distributing laterals by the total acreage, after making reasonable allowances for seepage. It is somewhat doubtful whether or not the lands received all of this water, because the disposition of water on individual tracts is not known, but, if they did, it surely represents a great waste. It means that there were applied to the land large quantities which did not benefit the growing plants. In the irrigation of alfalfa, for instance, the frequent practice is to run the water in long furrows. Before any water has reached the farthermost end of the field, the soil at the upper end has become saturated to depths far beyond those required by plant roots. This can be remedied by running the water in shorter furrows, by the use of additional heading ditches, or by using a sufficient head of water to carry it to the farther end quickly. The latter plan is by far the better, but, under the continuous-rate method of delivery, it is frequently impossible, because of lack of sufficient water at one time. As a general thing, water can be saved by giving the irrigation a large volume for a short time rather than a small volume for the entire season. A plan of rotation can frequently be effected by mutual agreement among those irrigators drawing water from the same lateral. Sufficient water is delivered to the head of the lateral, at a continuous rate, to furnish the contract allowances for all land under it. The irrigators then agree among themselves as to the times of distribution, and arrange a schedule of delivery accordingly. The water is distributed by the patrolman in accordance with these agreements. On some of the newer projects this plan has been adopted with excellent results, but, on the Sunnyside Project, there are several different contracts outstanding, as the Government assumed to carry out all contracts in force between the former owners of the system and the water users. On this account it has been very difficult to put improved methods into practice, although the necessity for adopting them is fully realized.

The engineering difficulties connected with the development of such a system are entirely eclipsed by the "human problems" encountered in operation. The human tendency has always been to take everything that is due—and more. If an irrigator is by contract entitled to 1 sec-ft. of water, he is likely to insist on having that quantity delivered whether or not he has use for it, even knowing that its application to his land would practically ruin his crops. He fears that by a relinquishment now he would forfeit his right to the water in the future. This human tendency will always be a source of trouble as long as water is delivered at a continuous rate. Some of the newer contracts allow so many acre-feet per acre per annum, or so much thereof as may be necessary for the production of crops, but the farmer is usually the judge as to the necessary quantity. While these provisions have certain advantages, the evil will never be cured until the irrigator is required to pay, according to a properly graduated scale, for the actual quantity of water used.

Another "human problem" encountered by the new administration was very satisfactorily solved after some experimental work had been done: The Sunnyside type of weir delivers from 2 to 8% more water than would be delivered over a sharp-crested steel weir under the same head. This was determined by calibrating the two types by volumetric tests. Each water user's allowance is calculated for him in inches of head over his weir, and each irrigator, of course, knows the number of "inches of water" to which he is entitled. In order to limit each irrigator to the exact quantity allowed to him, it would have been necessary to reduce slightly the head allowed each. The reason for such a reduction could never be explained to the layman, and would have brought forth very bitter protest, and probably litigation would have followed; but, by substituting a weir sheared from thin steel plate, each irrigator could still get the same head of water over his weir, but not the excess water to which he had become accustomed. The reduction in individual cases could hardly be detected, but in the aggregate a saving of nearly 4% of the water supply would result. The steel weir is being installed on the new work of the project, and is gradually being substituted for the old type in present structures.

In designing an irrigation system, as well as a power-plant, it is necessary to provide for the "peak load." In power-plants this feature usually becomes the major item in the cost of operation. In irrigation, however, the situation in this regard is rarely so acute. The maximum demand may continue for 15 or 20 days, and, by judicious management, it is frequently possible to extend it over a longer period. The carrying capacity of a canal and distributing laterals, and thus the cost of the project, is largely fixed by the maximum requirement. By intelligent distribution of the water, with regard to the time of irrigating the various crops, and by encouraging the water users to plant a diversity of crops, this peak can be broadened, thus reducing a rate of flow that otherwise might be difficult to maintain. For instance, alfalfa requires a greater quantity of water than most other crops. Under the same project, this crop ripens and is cut at about the same time. It is irrigated after each cutting. Under the Sunnyside Project, three cuttings are secured, hence, if the entire area was cropped to alfalfa, there would be three "peaks" to the distributing load during the season, and they would be so high that it would be impossible to supply the water, with the present ditch capacities; but, where alfalfa fields alternate with orchards, potatoes, beets, timothy, clover, small fruit, etc., the demand is much more uniform. The extent to which conditions in this regard can be improved by encouraging diversified farming among the irrigators, is somewhat surprising. To do this effectively there is need for exhaustive and systematic study of the most efficient duty of water, for different crops and for different soils. Only the most general results have been secured in this line, up to the present time, nor is it possible to secure more specific data elsewhere than on the project where the data are to be utilized.

An experimental irrigation farm should be as much a part of the equipment of a large irrigation system as the ditches themselves. Such a farm should be placed in charge of a skilled agriculturist, and then the results should be presented to the water users in an attractive and forceful manner.

Fig. 1 shows the hydrographs obtained at all stations on the Sunnyside Project during the season of 1909. These illustrate the "peak loads" for that project. The solid lines represent the inflow into each beat. The dotted lines represent the outflow plus the diversions in each beat. The differences between these two curves, shown as shaded areas, represent losses. They are numbered to correspond with the beat numbers, as given in Table 1.

The volume carried by the canal is regulated at the intake and at the Zillah Waste-way, just above the 17-Mile gauging station. The lands above the 23-Mile station are nearly all in orchards, while below this point alfalfa is the prevailing crop. The effect of the necessary manipulation of the Zillah Waste-way to supply the variable demand for alfalfa irrigation is well illustrated in the 23-Mile hydrograph (Fig. 1). The first irrigation of alfalfa occurred during May. Cutting began about the middle of June, and water had to be wasted or lands at the lower end of the canal would have been damaged and the safety of the canal menaced. As soon as the alfalfa was cut, the fields required another irrigation, which began about July 5th. The second cutting was made early in August, and irrigation of the cut-over fields began about August 15th. The third cutting began about September 15th, and other crop requirements began to fall off, which necessitated shutting down the supply very suddenly.

The gates to individual measuring boxes are arranged so that the water user may shut off his supply at will, but he cannot open it to deliver more than a certain quantity without breaking a padlock and subjecting himself to penalties. The result is that considerable quantities are frequently turned into the main canal without the knowledge of the management, although patrolmen are always on the watch for such an emergency. The head-gates of laterals are being adjusted continually, and this requires continual adjustment at the head and waste-way in the main canal. At the time of maximum requirement—August 14th to 26th in 1909—the situation in this regard became very acute, for the canal and laterals were almost to the breaking point in many places, and a few second-feet more would cause serious damage.

Table 7 shows the monthly and seasonal average of the inflow, outflow, diversions, and losses in 1909 on the Sunnyside System, considered in four principal sections. The sections are, respectively, 30, 18, and 12 miles in length, for the main canal, and 9 miles for the

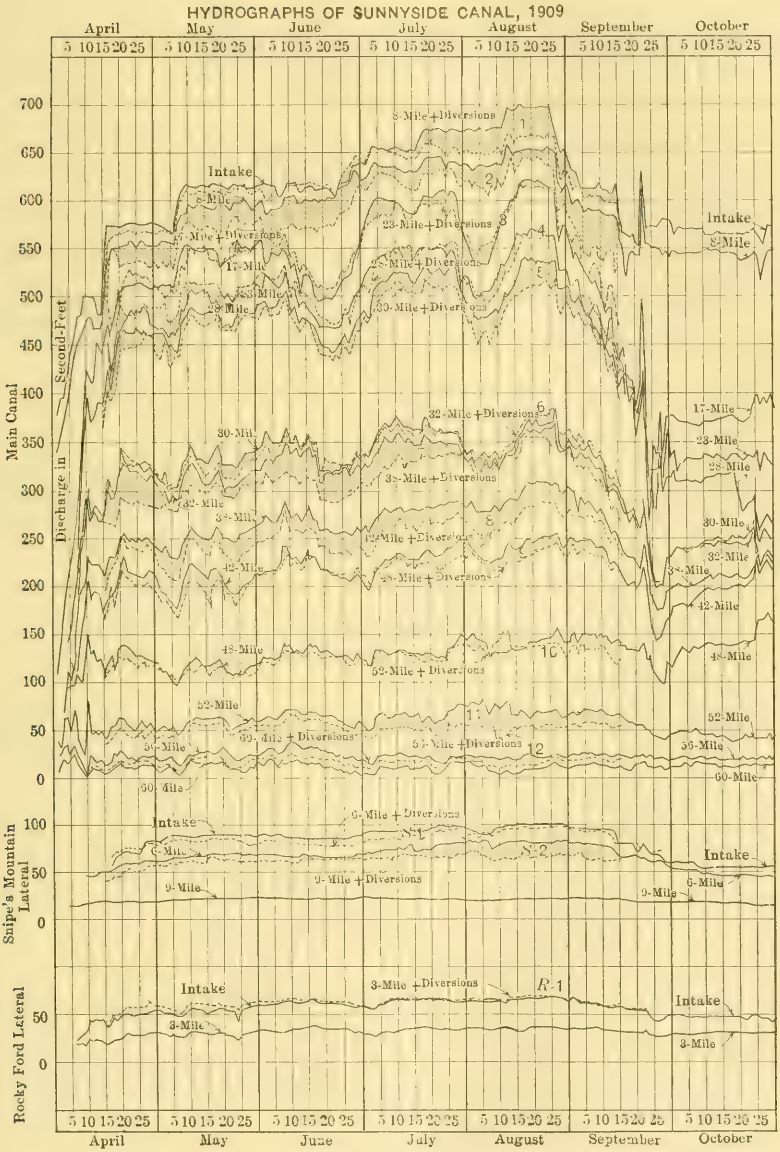

HYDROGRAPHS OF SUNNYSIDE CANAL, 1909
April
May
June
July
August
September
October
5 10 15 20 25
Main Canal
Discharge in Second-Feet
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
8-Mile + Diversions
1
Intake
8-Mile
2
17-Mile + Diversions
23-Mile + Diversions
3
4
17-Mile
28-Mile + Diversions
5
23-Mile
28-Mile
30-Mile + Diversions
32-Mile + Diversions
6
30-Mile
38-Mile + Diversions
7
32-Mile
38-Mile
42-Mile + Diversions
8
42-Mile
48-Mile + Diversions
9
48-Mile
52-Mile + Diversions
10
52-Mile
11
60-Mile + Diversions
56-Mile + Diversions
12
56-Mile
60-Mile
Intake
8-Mile
17-Mile
23-Mile
28-Mile
30-Mile
32-Mile
38-Mile
42-Mile
48-Mile
52-Mile
56-Mile
60-Mile
Snipe's Mountain Lateral
100
50
0
Intake
6-Mile + Diversions
S-1
6-Mile
S-2
9-Mile + Diversions
9-Mile
Intake
6-Mile
9-Mile
Rocky Ford Lateral
50
0
Intake
3-Mile + Diversions
R-1
3-Mile
Intake
3-Mile

FIG. 1.

principal lateral. For general use, the losses are expressed in percentages of the inflow into each section, and in second-feet per acre of wetted area in the bed and banks of the canal. Seepage is not properly expressed as a percentage of flow, because it may occur from a still pond, but it is given because it is a convenient unit and is useful for relative comparisons.

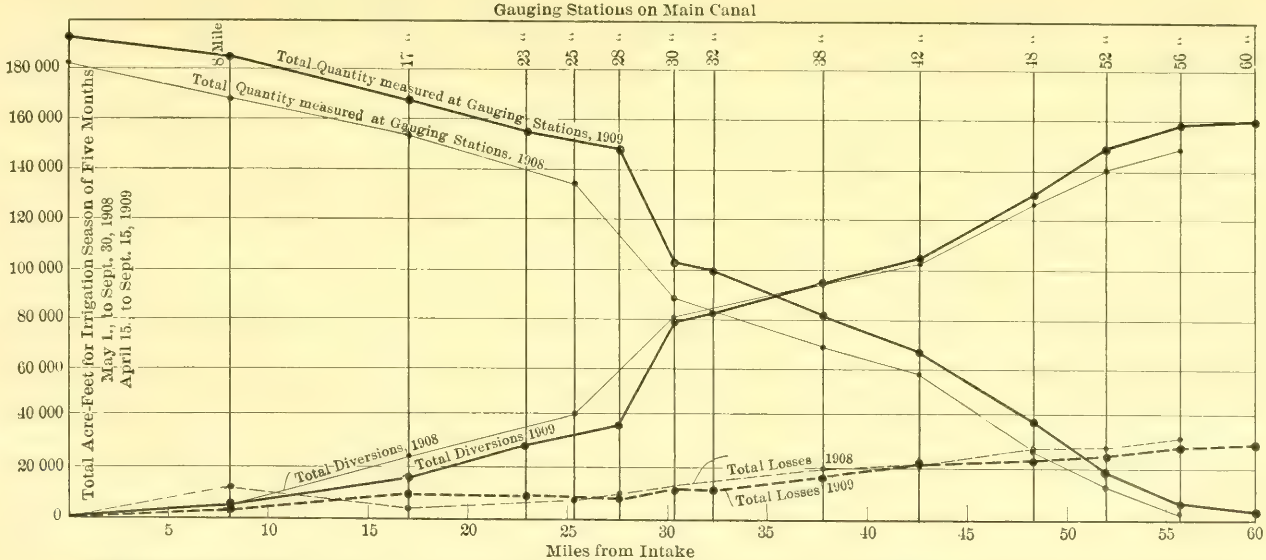
The losses shown in Table 7 are not seepage alone, but include the uncompensated errors of the methods used, hence daily losses, as shown in Fig. 1, will be more variable than monthly averages, and should not be used for general deductions. Observing this precaution, it is seen, from Fig. 1 and the foregoing tables, that the maximum flow in the main canal at the head was 11% greater than the average for the season. The highest diversion in one month into the distributing laterals of the system was 8% greater than the average for the season, while the average losses for the month of greatest diversion was 38% greater than the average losses for the season. This disproportionate increase in the losses with an increase in the flow of the canal and laterals is very striking, and indicates the necessity of keeping the demand as nearly uniform as possible.

Fig. 2 shows the seasonal disposition of all water received at the intake of the canal. For purposes of comparison, the results for 1908 are also given for the same length of time, except that the period began 15 days earlier.

The foregoing tables and figures show briefly the results of hydrographic work secured on the Sunnyside Canal in 1909. This work is being continued as an operation adjunct. In connection therewith complete crop statistics are being gathered, and it is likely that these data, taken together, will reveal the wastefulness of certain present-day practices and suggest methods whereby the efficiency in operation of such a large system can be continually improved. Hydrography is seen to be at the foundation of any investigation of this nature, but its use in this connection is comparatively new. The exigencies of the case demand a much higher degree of accuracy than heretofore has been considered possible. Yet if refined methods can be adopted and practicable results secured it offers a possible method of determining the flow in many canals, which, on account of low gradients, could not be measured in any other way.

TABLE 7.—Inflow, Outflow, Diversions, and Losses in Four Principal Sections of Sunnyside Canal, in 1909.

	April 16th to 30th.	May.	June.	July.	August.	September 1st to 15th.	Mean.
Main Canal:							
Intake to 30-Mile.							
Inflow	579	609	620	665	685	616	636
Outflow	314	329	338	360	347	326	340
Difference	265	280	282	305	338	290	296
Diversions	230	255	264	262	272	246	258
Losses, in second-feet	35	25	18	43	66	44	38
Losses, in percentage of inflow	6.0	4.1	2.9	6.5	9.6	7.1	6.0
Wetted perimeter, in acres	154.8	155.8	155.5	158.6	160.6	155.6	156.8
Losses, in second-feet per acre	0.226	0.160	0.116	0.269	0.412	0.283	0.242
30-Mile to 48-Mile.							
Inflow	314	329	338	360	347	326	340
Outflow	125	112	128	128	137	144	129
Difference	189	217	210	232	210	182	211
Diversions	146	169	169	185	181	158	171
Losses, in second-feet	43	48	41	47	29	24	40
Losses, in percentage of inflow	13.7	14.6	12.1	13.4	8.4	7.4	11.8
Wetted perimeter, in acres	71.1	71.0	72.1	81.5	81.6	79.5	76.1
Losses, in second-feet per acre	0.605	0.676	0.568	0.577	0.355	0.304	0.526
48-Mile to 60-Mile.							
Inflow	125	112	128	128	137	144	129
Outflow	10	10	11	7	7	9	9
Difference	115	102	117	121	130	135	120
Diversions	95	88	100	103	106	105	99
Losses, in second-feet	20	14	17	18	24	30	21
Losses, in percentage of inflow	16.0	12.5	13.3	14.1	17.5	20.8	16.3
Wetted perimeter, in acres	23.9	23.9	25.5	24.9	26.9	25.9	25.2
Losses, in second-feet per acre	0.837	0.586	0.667	0.723	0.892	1.16	0.837
Snipe's Mountain Lateral:							
0 to 9-Mile.							
Inflow	70	86	82	93	95	90	89
Outflow	18	20	20	20	20	20	20
Difference	52	66	62	73	75	70	69
Diversions	48	57	54	56	59	56	57
Losses, in second-feet	4	9	8	17	16	14	12
Losses, in percentage of inflow	5.7	10.5	9.8	18.3	16.8	15.6	13.5
Wetted perimeter, in acres	18.3	19.0	19.1	19.1	20.1	19.5	19.2
Losses, in second-feet per acre	0.22	0.47	0.42	0.89	0.80	0.72	0.63



DISPOSITION IN SUNNYSIDE CANAL OF WATER RECEIVED AT INTAKE DURING IRRIGATION SEASON OF FIVE MONTHS IN YEARS 1908 AND 1909

FIG. 2.

It has been estimated that 1 sec-ft. of water applied to lands under the Sunnyside Project creates for them a valuation of $80 000. Every second-foot of water, therefore, which by judicious management can be transferred from waste to beneficial use, increases the taxable property of the State that much, and adds its due proportion of homes to the social system.

It would seem, therefore, that almost no limit of accuracy should be recognized for hydrographic work on an irrigation system, because hydrography is the essence of conservative operation. The fact remains, however, that canals have been operated after a fashion with only the crudest general knowledge of the flow. Such methods are not destined to continue, for, although the water supply may be bountiful and the prevention of waste an unnecessary expense, systematic hydrographic work is not the less important. The excessive use of water on land is a most harmful practice, for, not only is the immediate owner depriving himself of profits which a more conservative use would insure, but he frequently works untold injury to his neighbors. Examples of this pernicious practice are only too numerous. It is practically certain that irrigated lands, the country over, would produce more and better crops if less water was used, and more attention was given to cultivation and the times and manner of irrigation. In determining the most effectual quantity of water for different crops and different soils, and in the proper delivery of this quantity after determination, the highest possible degree of accuracy in canal hydrography must be attempted.

Vol. XXXVI. NOVEMBER, 1910. No. 9.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

NOTES ON THE BAR HARBORS AT THE ENTRANCES TO COOS BAY, AND UMPQUA AND SIUSLAW RIVERS, OREGON.

By Morton L. Tower, M. Am. Soc. C. E.

To be Presented December 21st, 1910.

When the improvement of harbor entrances on sand coasts are planned or are being discussed, attention is given to the effect of the scouring action of the ebb current, the littoral drift, or alongshore currents, the resultant sand movement, and the prevailing direction of the storm winds. The path of the flood-tide currents has seldom been mentioned as a controlling factor.

In this paper attention is called to the fact that these flood-tidal currents are an important factor, if not the main one, in causing troublesome shoals at harbor entrances. The writer does not intend to imply that the other elements are not to be studied, or are of no consideration, but, as they have been discussed at some length by advocates of different systems of jetties in papers* before this Society, he will confine his remarks to the action of the flood-tide and its effect

---

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

* "Jetty Harbors of the Pacific Coast," by Thomas W. Symons, Captain, Corps of Engrs., U. S. A., *Transactions*, Am. Soc. C. E., Vol. XXVIII, p. 155.

"Description of Coos Bay, Oregon, and the Improvement of its Entrance by the Government," by William W. Harts, M. Am. Soc. C. E., *Transactions*, Am. Soc. C. E., Vol. XLVI, p. 482.

Papers on Harbors, Inter. Eng. Congress, *Transactions*, Am. Soc. C. E., Vol. LIV, Pt. A, p. 137.

at three harbors on the Oregon Coast, namely, Coos Bay, and the Umpqua and Siuslaw Rivers.

That portion of the Oregon Coast between Cape Arago on the south, and Heceta Head on the north (Fig. 6, Plate CLXXVIII), presents a stretch of sand nearly 50 miles in length. It is broken by the above-named harbors and by five creeks which drain lakes of considerable extent between the harbors.

Coos Bay is immediately north of Cape Arago, the harbor entrance being well protected by the cape from all storms from the south and southeast. The Umpqua River entrance is 25 miles north of Cape Arago, and that of the Siuslaw River is 7 miles southward from Heceta Head.

Cape Arago is a low flat cape extending about 4 miles beyond the general coast line above low water. Beyond low water the writer has traced the reefs about 8 miles, with depths on the bare rocks of 60 fathoms at the outer end. On either side of the reef there is a depth of 90 fathoms to sandy bottom. At the shore the rocks and reefs generally rise sheer from depths of from 40 to 60 ft. It is evident that no littoral drift of sand occurs to any great extent around this cape.

Heceta Head is a bold promontory extending only 1 or 2 miles beyond the coast line. The offshore slope is much less steep than at Arago, and the under-water reef is not so prominent, yet the bare rocks extend into general depths of 40 and 50 ft. To the north the coast line, for 15 miles to Cape Perpetua, is rockbound. It is evident that there is no chance of sand movement from the north.

Along the coast a marine growth is found on the sandy bottom of the ocean at depths of more than 50 ft. This growth consists of shell-fish and the lower orders of animal life on which fish feed; bottom fish of the sole, halibut, and skate species, are to be found on the sandy bottoms, although halibut generally feed close to the rocks. On sandy coasts, no marine growth, other than animal life possessing some means of accommodating itself to a changing bottom, appears inside the 40-ft. contour. A good illustration of this may be found in the fact that, on sandy bars, buoy chains and anchors do not accumulate barnacles where the chain lies on the sand in the shoal locations; while chains of outside buoys, generally placed in from 40 to 80 fathoms, accumulate growth for their entire length.

This evidence proves that the large movement of sand is confined to the shoaler depths of water between the 40-ft. contour and the shore. This is reasonable. The great factor in moving sand is the change in form of shoreward moving waves from what has been termed by Thomas Stevenson as oscillating waves to waves of translation. The change occurs when the under-water portion of a wave of oscillation encounters the bottom and is checked; the inertia of the upper portion carries the water on until the top of the wave falls over.

Waves of oscillation produce very little horizontal force, while the energy developed by waves of translation is enormous. It has been measured on the coast of England and has amounted to as much as 6 000 lb. per sq. ft. It is undoubtedly far more when the great waves of the North Pacific Ocean storms break on the coast. Under the influence of the waves, the sands on the beach are constantly undergoing change, thereby affecting its profile.

Long periods of quiet ocean without unusual storms produce a short beach, the sand being pushed shoreward; between the storm high water and low water a contour assumes many small irregularities. During periods of violent storms the beach is long, the contours are straight and parallel with the beach line, and the sands are beaten down until a wheeled vehicle scarcely leaves an imprint. These movements are local, however, and if there is a resultant movement of sand along the Oregon Coast, it is not apparent in the accumulation of sand at either end of the area between Heceta Head and Cape Arago. As far as the improvement of harbors for the benefit of the present civilization is concerned, the resultant littoral movement or the accumulation or disappearance of the sand are not factors of greatest importance.

The original source of this sand area is hard to name, and like other geological phenomena, is more or less a matter of theory; it may be the deposits from the Umpqua River, during the many geological ages that the land has been above the water. From the beach the sand stretches shoreward to 5 miles in the middle distance between the two capes. It is bare of vegetation, and near the timber line forms immense dunes, which reach elevations of 150 ft. Inside the timber line it underlies a stratum of from 4 to 8 ft. of soil under the forest. In the form of sandstone of varying degrees of hardness it overlies the lignite and shale deposits of the southern end of the country, extending well into the western slope of the Coast Range.

Figs. 1 to 5, Plate CLXXVIII, show the outline of the shores at the three harbors, the under-water depths being expressed in feet. It will be noticed that in their unimproved state the shore lines were very similar. The entrances consisted of long curved channels having large areas of shoal water on one or both sides.

The entrance at Coos Bay is shown on Figs. 1 to 3, Plate CLXXVIII, and includes the harbor in 1863 before any improvement was undertaken, in 1885 before the north jetty was commenced, and in 1907, the latest available data. Fig. 4, Plate CLXXVIII, is a sketch of Umpqua River where no improvement has been undertaken, and Fig. 5, Plate CLXXVIII, is a sketch of Siuslaw River where a jetty has been started, but has not yet reached a sufficient length to create any improvement on the bar.

Coos Bay and Umpqua River have controlling natural headlands and reefs of sandstone on the south side of the channel to direct the current in the gorge or harbor throat. Siuslaw, however, has sandy shores on both sides of the entrance, the stiff clay bank underlying Cannery Hill being too far upstream to be a controlling factor at the bar. The present jetty would form a controlling reef and be a valuable aid to one on the south spit.

The currents at harbor entrances, which result from the rise and fall of the ocean with the tidal wave, are similar at all harbors. Beginning with high tide, the outgoing current commences about 30 min. after actual high water, the delay being due to the inertia of the moving water in the channels. At this time, and at low-water slack, the greatest slopes or differences in elevation between points inside and outside the harbor occur. The first currents occur generally along the shores or in secondary channels, and sometimes they last an hour or more before the change in the direction of the current in the main channel takes place. As the current gains headway, it tends to follow the path of the main channels through the harbor throat and to sea; if there are no obstructions, it flows out with unchanged direction. On reaching the sea, the current is checked by the waves and by the friction of the ocean water, and the suspended matter is deposited.

At the first of the flood-tide, the same delay in the main channel currents occurs. The water rising along the shore, which, owing to the crescent shape of the bars, is a short distance from the inner harbor near the high-water line of the spit, pushes through the secondary channel which, in this vicinity, is generally found across the shoal.

The velocities across the shoal are considerable, and in the shallow water the sand agitated by the waves is carried along, and the water enters the harbor channel with a capacity load.

During the whole of the flood-tide, the flood current, owing to the influence of the shoreward moving waves and the short direct route, continues to push over the spits into the channel. During rough weather, when the violence of the waves disturbs greater quantities of sand, the proportion of water entering across the spits is greatly increased, and continues for a large portion of the ebb-tide as well, while the seas roll across the spits into the channels.

The inner or bay side of the spits, over which the flood currents enter the channel, will always be found to be steep, with a rolling slope of sand during flood-tide and a caving bank during the ebb current. The sand entering the channel is carried out through the harbor throat and again settles on the outer edge of the shoals, where the current is decreased on entering the ocean. In other words, the cycle is commenced again, and the great quantity of sand forming the bar is continually making round trips in over the spits with the flood-tides and out through the channel with the ebb currents. During storms the action is increased, as sand is stirred up to greater depths and carried shoreward with greater velocity.

The most effective place in which to control this movement is the shallowest portion of the cycle, or along the ridge of the shoal. This is always found on the convex bank and near the harbor channel. The danger to be provided against is the location of a jetty too close to the channel, where the structure would be undermined when the supply of sand from the ocean side was cut off. A generous allowance for flat slopes should be provided for on the channel side of the inner portion of the jetty. The jetty in the shoaler portions may be built of small stones and a thick brush mattress, depending on the accumulating sand to provide the real and permanent barrier. The jetty should be carried to high-water-crest height, and as the sand appears above that height, the available area should be planted with suitable vegeta-

PLATE CLXXVIII.
PAPERS, AM. SOC. C. E.
NOVEMBER, 1910.
TOWER ON
BAR HARBORS ON THE COAST OF OREGON.

ENTRANCE TO COOS BAY.
OREGON.

Soundings show depths in feet at mean lower low water
Mean Rise of tide above this plane is ____5.6 ft.

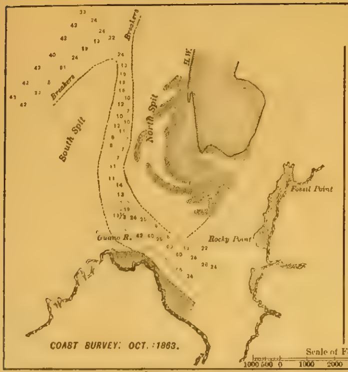


FIG. 1.

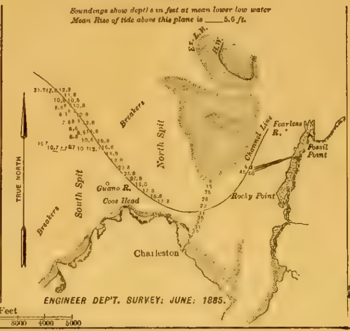


FIG. 2.

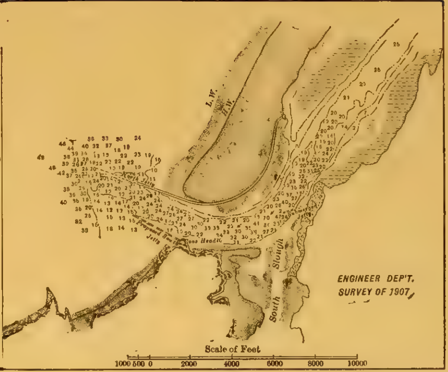
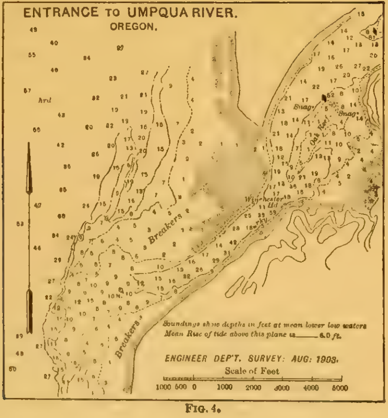


FIG. 3.

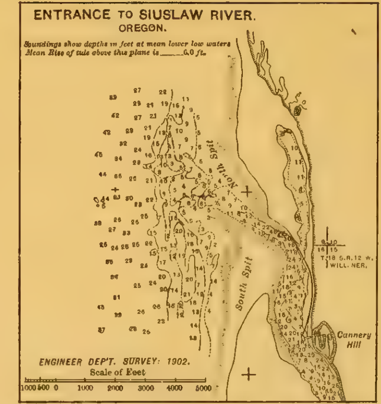


ENTRANCE TO UMPQUA RIVER.
OREGON.

Soundings show depths in feet at mean lower low waters
Mean Rise of tide above this plane is ____6.0 ft.

ENGINEER DEP'T. SURVEY: AUG: 1903.

FIG. 4.

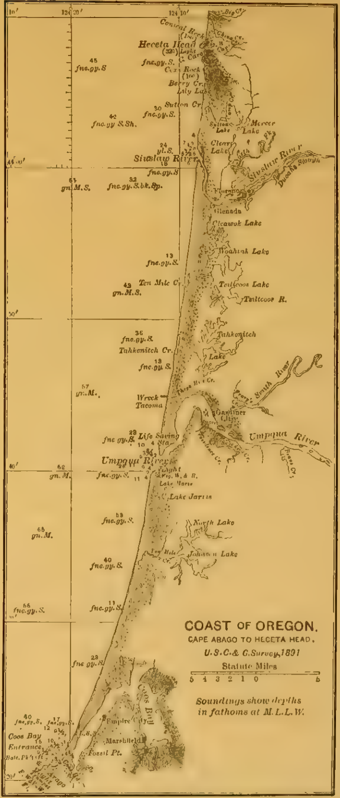


ENTRANCE TO SIUSLAW RIVER.
OREGON.

Soundings show depths in feet at mean lower low waters
Mean Rise of tide above this plane is ____6.0 ft.

ENGINEER DEP'T. SURVEY: 1902.

FIG. 5.



COAST OF OREGON.
CAPE ABAGO TO HECETA HEAD.
U.S.C.& G.Survey,1891

Soundings show depths in fathoms at M.L.L.W.

FIG. 6.

tion. The decaying sea grass and driftwood will provide sufficient soil to maintain Holland or sand grass (*Arunda Arenaria*). The sand, caught and held by the grass, will continue the work above tide, and once out of the reach of the waves, the jetty is reasonably safe. In this way provision is made for the inner or easy end of the jetty. The outer end should extend into such depths that the sand will not pass around it in water of less depth than is expected to be maintained across the bar.

There will always be a bar or section with less water than is found in the gorge or harbor throat, unless expensive and continual dredging is resorted to, an expedient so costly as to be warranted only at the principal harbors of the world.

As an example of the difficulty that may be expected in maintaining a jetty in considerable depths, it may be stated that for 800 lin. ft. the outer end of the Coos Bay jetty was built three times to 24 ft. above low water and beaten down at the extreme end to 20 ft. below low water, or only a few feet above the surrounding sand. At the present time it slopes to just above low water in about 800 ft. from its outer end. This portion was built originally in from 20 to 24 ft. of water, at low water. The specifications for the stone used allowed one-fourth to be of pieces weighing from 400 lb. to 2 tons, one-half to be of pieces weighing from 2 to 4 tons, and one-fourth to be of pieces weighing more than 4 tons each. The largest pieces received weighed as much as 18 tons. The outer end of the jetty, as will be seen by reference to Plate CLXXVIII, is normal to the direction of the waves.

Referring again to the plans, Fig. 1, Plate CLXXVIII, shows the bar in its natural condition, before any work whatever was commenced. The entrance was well to the north, with a large area of shoal on both spits, and there was a narrow erratic channel changing in depth and direction with each storm. The spits were very low, being exposed only at extreme low water, the waves carrying across the bay and breaking with great force on Rocky Point. At long intervals the channel would break out in a position near the present location, and better depths and a shorter shoal always resulted. This led to a desire to make the southward location permanent, and was the result expected from the original project for the jetty extending from Fossil Point to Coos Head, Fig. 2, Plate CLXXVIII. This project was adopted in 1879 and abandoned in 1889 when a new project, along the lines of the more successful jetty built at Yaquina Bay, was adopted. At the time the first project for the Coos Bay jetty was commenced, the work of improvement at the harbors of the Great Lakes by jetties or sea-walls was in active progress under the direction of the United States Engineer Corps, and the same methods and styles of construction were used at Coos Bay, which was the first Pacific Coast harbor entrance for which Federal appropriations were made.

Shortly after commencing work at Coos Bay, appropriations were secured for the improvement of Yaquina Bay, and work was commenced there, a similar style of construction being proposed. As the Yaquina work was in a more exposed position, the method of construction was soon found to be inadequate, and the Assistant Engineer, James S. Polhemus, M. Am. Soc. C. E., proposed, and was directed by the Engineer Officer in charge of the work, to use the type of jetty now adopted at all harbor entrances along the Pacific Coast north of San Francisco.

There has been continual development in the methods and plant used for jetty construction, especially at the mouth of the Columbia River, where liberal appropriations and the magnitude of the work have allowed the building up of a splendid plant for carrying on the work. The construction of the jetty and the details of the plant used have been fully described by Major Hart.*

The original type of jetty built at Coos Bay under the first project consisted of large timber cribs, built cob-house style, of sawn 12 by 12-in. timbers bolted together. The cribs were placed in line, filled with small rock and sunk, and then rip-rap was dumped along the sides.

Owing to the rapid destruction of the timber by the teredo, as well as the expensive cribwork and the impossibility of placing the cribs in the more exposed positions later considered desirable for jetties, this type of construction has been finally abandoned on this Coast.

The construction of the inner jetty certainly produced results on the entrance to Coos Bay. The curve of the channel at the south end of the bay was eliminated. The height and width of the north spit were increased, and the position of the channel across the outer shoal was held more permanently and farther south than the old channel. The depths were not much increased, and a well-developed flood-tide channel, several hundred feet wide, with a depth of 1 ft. at low water, was generally found just southward from the high-tide line of the north spit.

---

* *Transactions*, Am. Soc. C. E., Vol. XLVI, p. 482.

Through this channel the first of the flood-tide entering the bay carried large quantities of sand. The extreme end of the north spit was scoured off, but the persistent action of the flood-waters across the shoal caused the channel to narrow between the end of the jetty and the sand island, and great quantities of sand were constantly being carried in over the shoals and out through the channels, with resulting constant changes in the bar depth.

The first work on the later project was commenced in 1891. The jetty was extended to its projected length, 10 368 lin. ft., by August, 1894, and during 1895 the crest of the enrockment was brought to half-tide height. Between 1895 and 1900, $240 000 were spent, completing the jetty by increasing and maintaining the enrockment, in which about 300 000 tons of stone were placed. As before mentioned, at the extreme end of the jetty the enrockment was built three times to the height of the tramway rails, 24 ft. above low water, and was as many times beaten down by the sea to 20 ft. below low water at the extreme end.

Immediate results followed the building of the North Jetty. The large quantity of sand entering the bay across the spit was stopped, and it commenced to build up behind the jetty. The south spit and bar, not receiving its supply of sand with the ebb current, was scoured down and the channel held in permanent position. The sand on the inner side of the jetty, across the channel from the outer end of the old work, was washed away. The flood current, no longer able to crowd in on the north side, commenced to push in along the south side of the channel, resulting in the prominent shoal across the south arm of the harbor. This shoal is inside, and does not interfere with commerce. The area north of the jetty has continued to accumulate sand and extend seaward. It has been planted to Holland grass, which continues the accumulation of sand above high water. The first four years after the completion of the jetty across the north spit witnessed the best bar depths (22 ft. at mean lower low water) in the history of the port. The position of the channel was fixed and has so remained.

The depth has been reduced at times to 17 ft. at mean lower low water, but is generally 18 ft.

The present condition of the channel is shown by Fig. 3, Plate CLXXVIII, which is the latest authoritative map of the locality, with a least low-water depth of 19 ft. The last work of jetty construction at Coos Bay was done in 1901, since which time Holland grass has been planted, the jetty has been cared for, etc. The tramway has disappeared, and the outer end of the enrockment needs rebuilding. The sand washing past the end and over the lower portions of the rock is commencing to cause shoals, and undoubtedly more work will be required very soon. The 18-ft. low-water depth accommodates the port's commerce very comfortably. It is as great as is to be found in the channels of the inner harbor for any great distance, and, while more depth would be desirable, the maintenance of works, in order to secure it, would be very expensive. The project under which the North Jetty was constructed included a second jetty on the south side of the channel to produce a permanent depth of 18 ft. by scour.

The results obtained by the single jetty on the north side have maintained the projected depth so successfully that no expenditure for the South Jetty has been warranted. The total amount of money appropriated for the improvement of Coos Bay entrance has been $938 750. It has been expended approximately as follows:

For the first project, adopted in 1879...........	$213 750
“ “ second “ “ “ 1889...........	675 000
Expended since closing of jetty work, for survey steamer, dredging, planting grass, etc., and on hand................................	50 000
Total................................	$938 750

As a result of the improvement at Coos Bay, the freight rate to San Francisco compared with that from Umpqua River—a port of the same nature as Coos Bay before its improvement, and of similar depth—is 50 cents per 1 000 ft. of lumber in favor of the improved port.

The Umpqua River, Fig. 4, Plate CLXXVIII, is one of the largest streams of the Pacific Coast, draining an area of more than 4 800 sq. miles which has the proverbial rainfall of the "Webfoot State." Heading in the Cascade Range in areas of fine pine forests, it crosses the drier valley between the Cascade and Coast Ranges, and breaks through the Coast Range in a narrow cañon, with a short narrow valley between the coast mountains and the ocean. One large tributary, Smith River, enters it from the north.

With all this splendid drainage area and immense flow, aided by the deflecting reefs near the harbor mouth, the river is unable to scour a desirable channel through the bar. The pressure of the sand washed in across the north spit holds the deep water hard against the rocks of the heads and reefs on the south side of the channel. At the Umpqua River entrance a jetty along the north spit, duplicating the single jetty at Coos Bay, would produce similar improvement, and could be economically constructed. Materials for construction are convenient and abundant on the Umpqua River, and a moderate improvement could be effected for a comparatively small expenditure.

At Siuslaw River, Fig. 5, Plate CLXXVIII, it will be noted that the entrance, while having all the characteristics of the other two harbors, is reversed, and the larger shoal area is on the south side of the channel. At this place a north jetty has been partly constructed by the Federal Government. The project was to create a depth through the shoal by scour.

The jetty was extended along the shore to a point opposite the inner edge of the break through the sands; then it curved outward, normal to the coast line. By the time the work was extended to the curve, the channel had moved northward, and, in 1897, the jetty was built entirely across the river, shutting it off. A narrow path was quickly cut around the end of the work, and, during the winter following 1897, a new channel broke out to the south in the desired location, and has not yet shifted to any great extent. The depth, however, is very unsatisfactory, as it does not permit the commerce to be handled economically.

Here, again, a jetty depending on scour alone has not been a success, and it has also been expensive to construct, owing to the scour and depth encountered at the end of the work while continually turning the channel. The project was finally abandoned by the General Government in 1902.

The port of Siuslaw, consisting of a legalized body representing the benefited property, has been organized under an act recently passed by the Oregon Legislature, has issued bonds, adopted a project, and commenced the construction of a jetty on the south side of the entrance, the idea being to cut off the sand movement into the channel and thus give the ebb-scouring current a smaller task to perform. Work has now commenced, and the results will be interesting.

This paper could have been greatly enlarged, but the writer's idea has been to call attention to only one element of harbor bar formation. Other points and theories of sand movement, with a full description of the methods of construction, have been presented in the papers and discussions previously mentioned.

Vol. XXXVI. NOVEMBER, 1910. No. 9.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

TIMBER PRESERVATION, ITS DEVELOPMENT AND PRESENT SCOPE.*

By Walter Buehler, M. Am. Soc. C. E.

To be Presented December 21st, 1910.

Timber preservation has not been developed from any one process, but from many; it has included the elimination of those not bringing results, the retention and development of those showing results, and the addition of new processes.

The first authentic report on timber preservation was probably that of a Special Committee appointed by this Society in 1880, which report was published in 1885.† The Special Committee discussed the various processes in use at that time, in great detail, and prepared a number of tables showing the results obtained; and it is interesting to know that a great many of its conclusions are accepted to-day by those conversant with the subject.

The writer will not attempt to review in detail the development of all the processes in use in 1880, but will confine this paper to the two basic processes, namely, Burnettizing and Creosoting, as practically all those in use to-day are either the developed basic processes or modifications of them.

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

* A table of standard practice for the preservation of timber for railroad ties and tie-plates, to accompany this paper, is filed in the Library of this Society.

† *Transactions*, Am. Soc. C. E., Vol. XIV, p. 247.

The Burnettizing process was patented by Burnett in 1838. The original mode of application was to steep the timber in an open tank. Burnett, however, soon adopted the "Bethell" method of placing it in closed retorts, thus forming a partial vacuum in order to remove all the air and sap, and then injecting the liquid under pressure.

The Burnett process was introduced in the United States at Lowell, Mass., in 1850, and was there worked by the Bethell method until about 1862. It seems to have been quite generally used in the Fifties by a number of railroads, but with indifferent success. In fact, these failures caused its abandonment for a time and the substitution of the old "Kyan" process, or use of chloride of mercury.

The Special Committee, after a thorough investigation of these failures, reported as follows:

"1. Original imperfections in the 'Bethell' process. The partial vacuum did not properly clear the timber of sap. This has since been improved upon by previously steaming the timber, to liquefy and vaporize the sap, before the vacuum is applied.

"2. It was probably a mistake to select bridge timber for this experiment; imperfectly as the work was done, it would have proved a far greater success if it had been applied to cross-ties.

"3. Operating upon unseasoned timber. As practiced in Europe, Burnettizing is exclusively applied to seasoned timber. This being generally imported from a distance, has a chance to dry in transit; or if cut in the vicinity of the works, it is piled up for several months before treatment, or is thoroughly steamed, so that the water may evaporate and make room for the solution. Moreover, it is also well dried before using, to prevent the zinc from washing out. As a confirmation of this view, it may be mentioned that while the bridge timber did not last well, several sets of switch ties which had been cut about 8 months and seasoned, were Burnettized at Owego, for the road department of the Erie Railway, and laid in its tracks, with the result that nine years afterward they did not show a particle of decay. These ties have been lost sight of since, but your committee has in its possession an oak tie, one of a lot of two car loads, seasoned and Burnettized at Owego, which lay in the track at Susquehanna station for 17 years, and is almost perfectly sound to-day.

"4. Insufficient pressure. It has been suggested that the pressure ought to have been some 200 pounds per square inch and continued 8 hours, instead of 4. This might have produced somewhat better results, but it is believed that the last cause, which remains to be mentioned, more fully accounts for the partial want of success.

"5. Undue haste in treatment. In accordance with the usual railroad practice of never ordering materials until they are imperatively required, the timber was not procured until the bridge which it was intended to rebuild was about ready to come down. Then there was great haste; the Burnettizing works were hurried up, and the timber went straight from the stump into the cylinder, and from that into the bridge, with very imperfect treatment. A pressure was applied to the operatives, instead of to the cylinder, and as a result the timber was 'put through,' without sufficient preparation, some of it hard frozen in winter.

* * * * * * *

"It has been found, however, both in this country and in Europe, that when zinc solutions are employed, weak enough not to injure the strength of the timber, they are likely to wash out under the action of rains and moisture, and to leave the timber unprotected. This is quite well shown by the ties on the Chicago, Rock Island and Pacific Railroad (Experiment No. 8), which are decayed and exfoliated on the outside."

The following is a summary of the various causes of failure, brought out by the Special Committee:

First.—Class of material treated.

Second.—Condition of seasoning.

Third.—Use immediately after treatment, instead of allowing timber to season.

Fourth.—Insufficient pressure.

Fifth.—Too much haste, and consequent poor work.

Sixth.—The leaching out of the salt.

It is along these lines that the Burnettizing process has been developed. Engineers to-day do not advocate the treatment of bridge timbers, nor, in fact, any timbers, with a solution of chloride of zinc, such treatment being confined principally to ties. The value of preliminary seasoning is realized, and at present few ties are treated without it. It is also known that, in order to obtain the best results, it is absolutely necessary to dry zinc-treated timber after treatment.

The writer agrees absolutely with the fifth cause for failure, as reported by the Special Committee, that is, "undue haste, and consequent poor work," which probably has had more to do with failures then and now, than any other cause.

It is now realized that the sixth conclusion, in the report of the Special Committee, was correct, and, profiting by this knowledge, the Burnettizing method is not condemned, but its use has been restricted. At present only certain timbers are treated with zinc chloride, and more care is exercised in the selection of the uses and localities for which it is recommended. The fact that zinc chloride is a good preservative and the cheapest, warrants its continued use, provided discretion is exercised. It would be as foolish to pay the additional cost for creosoting ties in arid countries, as it would be to try to economize by the use of zinc chloride in swampy countries.

The strength of the solution to be used was mentioned in the report of the Special Committee, and it was concluded that too great a strength caused timber to become brittle. This is true to-day, and a 5% solution is probably the strongest now in use.

The strengths of the solutions vary from 2 to 5%, depending on the character of the timber to be treated; naturally, the denser the timber, the denser the solution.

The Bethell process, or Creosoting, was invented and brought into use in 1838 by Mr. John Bethell, of England, and in his discussion of the paper by Mr. H. P. Burt, in 1853, he made the following remarks:*

> "Experiment proved that Oil of Tar, or Creosote, was perhaps the most powerful coagulator of the albumen [of wood], whilst it, at the same time, furnished a water-proof covering for the fibre, and its antiseptic properties prevented putrefaction. If, then the operation of injection was well performed, there was every reason to anticipate the perfect success of the system. He found that by forcing at least 7 lbs. of Creosote oil into each cubic foot of timber, the process was perfect. * * * For railway work, 7 lbs. per cubic foot would suffice, but, for marine work, it was better not to have less than 10 lbs. per cubic foot.
>
> "He was inclined to prefer the employment of porous timber; it absorbed the Creosote more readily—was more perfectly saturated—was cheaper in its first cost, and when properly prepared, would last longer than heart of oak or any other very solid timber. * * *
>
> "The best timber for use was young, growing wood, *thoroughly dried;* if it was fresh cut, or had been floated, so as to saturate the pores with water, there was great difficulty in creosoting it. * * *
>
> "Mr. Bethell had experienced so much difficulty in procuring a proper quality of oil of tar, that he was compelled to establish manufactories and to distil it, to suit his own purposes."

Speaking further of its use and success, the Special Committee reports† that:

---

* *Minutes of Proceedings*, Inst. C. E., Vol. XII, p. 225; also in *Transactions*, Am. Soc. C. E., Vol. XIV, p. 265

† *Transactions*, Am. Soc. C. E., Vol. XIV, p. 266.

"As a protection against marine worms (the *Teredo Navalis* and *Limnoria Terebrans*) creosote is the only known preservative, and if there be enough of it injected it is thoroughly efficient. All other substances which have been tried, have failed, but the success of creosote has been established by abundant evidence all the world over.

"The English have found 10 to 12 pounds to the cubic foot sufficient in their harbors. The Dutch and Belgian engineers use about the same. But the French, relying upon a series of very careful experiments, extending over a series of years, by Mr. A. Forestier, consider that about 19 pounds to the cubic foot is required in their harbors in order to be quite safe against the *teredo*. This latter quantity has been used in this country by Mr. J. W. Putman for piles exposed along the Gulf of Mexico, and it seems probable that the higher temperature of the sea water, and consequent greater activity of the *teredo* in the French and our own southern harbors, requires a more thorough impregnation with creosote than in the northerly waters to afford immunity.

"The conditions under which creosoting is done in England differ from those in this country in two important particulars:

"1. The English operate upon *seasoned* timber, which, as it is chiefly brought from the islands of the Baltic, from Norway, and from Sweden, generally reaches them some 5 or 6 months after it is cut, and frequently remains stacked up some months more after arrival before it is creosoted. All the English engineers specify that 'the timbers shall be thoroughly dry before being creosoted,' while in this country we have almost invariably operated upon freshly cut timber, full of sap.

"This has led to steaming the timber previous to its injection with creosote (as well as with the metallic salts), in order to vaporize the moisture and make room for the solution. There are several methods of effecting this steaming, covered by a number of patents more or less meritorious, but the committee has included them under the general head of steaming in describing some American experiments.

"It is understood that steaming is now also used abroad, particularly in Germany, even when seasoned timber is injected, it being considered a valuable improvement upon the original process of Mr. Bethell.

"2. Creosote is cheap and abundant in England, while it is comparatively scarce and dear in this country. This, together with the higher price of labor and the longer time required to operate upon freshly cut timber, has made creosoting so much more expensive here than in England that in a majority of cases calculation showed that it was cheaper to let the timber rot and to replace it than to go to the expense of preparing it against decay.

"This condition of affairs brought about a considerable number of inventions and experiments to circumvent the foreign experience and to make a little creosote perform as much as a great deal. None of these can be said to have been successful, and it is one of the anomalies which at first much puzzled your committee that the record of creosoting experience in this country should chiefly consist of failures, while the process is a thorough success in England."

In this short comment on creosoting, the Special Committee has dealt with all questions of importance, namely:

The quantity of creosote;
The character of the creosote;
The kind of timber to be treated;
The conditions of timber best for treatment;
The best method of seasoning the timber efficiently.

It is by reason of a better understanding of these questions that the art of creosoting has developed. Differences of opinion will be found on all these matters, but nevertheless the art, as a whole, has progressed.

Timber must be protected against decay, attacks of land and water insects, and, for some uses, it must be water-proof. In order to answer properly any of these questions, one must have a thorough understanding of decay, of the characteristics of the insects to be guarded against, of the timber itself, and of the preservative.

In order to answer properly the question in regard to the quantity of creosote to be used, it is necessary to know whether the timber is to be preserved against decay, against mechanical destruction by insects, or whether it is to be water-proofed.

If it is to be protected against decay, the locality in which it is to be used must be known, as well as the climatic conditions.

If timber is to be protected against marine insects, it is necessary to know whether it is to be used in Southern or Northern waters.

If it is to be water-proofed, it is necessary to know for what uses it is intended, and its characteristics.

The cause of decay is now generally understood, and the proper quantity of creosote necessary for its prevention is receiving considerable attention. Owing to the increased cost of creosote oil, and its comparative scarcity in the United States, processes have been developed, in the past few years, in which small quantities of oil are used, which it is claimed will produce the same results as the larger quantities used in the past.

These processes are now commonly known as the empty-cell processes. The older process is known as the full-cell process, and its advocates claim that in order to preserve timber effectually, it is necessary to use enough creosote to fill the cell structures. They also claim that the desire to reduce the cost of preserved timber by the use of smaller quantities of oil, has produced certain patented processes, the claims for which cannot be fulfilled.

Advocates of the empty-cell process claim that it is only necessary to paint the cell walls to prevent decay, and that, by their special process, it is possible to fill the cell structure completely with oil, and then withdraw most of it. Thus the cell structure is virtually painted with a small quantity of oil.

It is not the writer's intention to go into this controversy, and he will only state that it is known that timber can be preserved by the full-cell process.

All the information we have to-day, as to the value of creosote as a preservative, is based on the resistance to decay of timbers which have been treated by the full-cell process, and whether it will be possible to reduce the cost by the use of smaller quantities of oil, is still an open question. It will only be answered when sufficient time has elapsed to demonstrate thoroughly its efficiency by actual experience. It is to be hoped, however, that this endeavor to reduce the cost of preserving timber, will not lead to false economies and, consequently, to false impressions of a good preservative.

In the protection of timber against marine insects in Southern waters, present experience would indicate the use of at least from 18 to 20 lb., and, in some timbers, as much as 26 lb. of creosote oil per cu. ft. If the timber is to be used in Northern waters, from 10 to 16 lb. per cu. ft. is advocated, depending on the character of the timber to be treated.

There are certain purposes for which timber is used to-day, such as the modern wood block pavement, in which that quality which makes creosote a good preservative is of less importance than that which makes it a good water-proofing material.

When creosote was first used in the United States to preserve timber for paving purposes, it was thought that it was only necessary to prevent decay, and specifications were based on experience with creosote in preserving timbers for ties and other purposes. These specifications naturally called for an oil similar to that which had been most effective in such preservation. It was soon found, however, that something more than a preservative was necessary. The timbers absorbed large quantities of water, expanded greatly, and destroyed the surface of the roadway. The natural development was to increase the quantity of oil used; this eliminated the trouble for a number of years, but it was discovered that in a short time the oil disappeared from the timber, absorption again took place, and trouble from expansion and contraction necessarily followed. This led to a study of the creosote itself, not only as a preservative for paving blocks, but also for timber, for it was naturally thought that if it disappeared from paving blocks, it would also disappear from timber. This deeper study into the preservative itself has developed it considerably.

It is now customary to differentiate the oils into those suitable for the preservation of timber, for paving blocks, and, possibly, for the protection of timbers against marine insects.

It is now generally conceded that the higher boiling constituents of the oil are the valuable ones, and whereas formerly high percentages of tar acids and naphthalene were specified, it is now customary to require low percentages of both. In fact, although early specifications called for not less than 10% tar acids and 40% naphthalene, those of to-day demand not more than 5% of the former and 25% of the latter.

When this oil is to be used for the treatment of paving blocks, the allowable tar acids are cut down to 1 to 2%, and the naphthalene to 10 or 12%, but where the timber is to be protected against marine insects, it is still customary to use oils with large percentages of naphthalene, for experience seems to prove that the best protection is afforded by oils of lower gravity.

Due to the development of creosote oil and its increase in gravity and viscosity, another question of importance was presented to the wood preserver, namely, the characteristics of the timber itself.

It was discovered that oils would penetrate certain timbers more easily than others, thus the timbers could be classified, those in each group having about the same factor of absorption.

Mr. F. J. Angier, Superintendent of Timber Preservation of the Chicago, Burlington, and Quincy Railroad, who has made a thorough study of this particular question, divides the timber into three groups, which he classes, *A*, *B*, and *C*:

Class *A* absorbing less than 22% in volume;
" *B* " between 23 and 30%;
" *C* " more than 30 per cent.

In Class *A*, he places such woods as red oak, pin oak, beech, and tamarac; in Class *B*, sweet gum, chestnut, sycamore, and poplar; and in Class *C*, tupelo gum, short-leaf pine, cypress, birch, and cottonwood.

Another classification which must be made is that of seasoned and green timbers. There seems to be no difference of opinion, at the present time, as to the fact that it is best, in all cases, to air-season timber before treatment; but conditions are such that this is not always possible, especially in the case of structural timbers. Almost all railroad ties in use to-day are being air-seasoned before treatment, but practically no bridge or structural timbers, and conditions are such that probably it will never be possible to air-season such timbers. Necessarily, then, some method must be devised to season them artificially. The writer will not attempt to go into the details of all the various methods in use to-day. Investigation has shown that, if timber is to be treated with an oil, it should be seasoned in oil, and if it is to be treated by a water solution, it should be seasoned in a bath of steam, precaution being taken not to steam it at too high a pressure, nor for too long a period, as excessive steaming materially reduces its strength.

The writer has attempted to bring out the important lines along which the art of timber preservation has developed, and it will be noted that this development has been practically that of the original basic processes, namely, Burnettizing and Creosoting.

Another development, which he wishes to review briefly, is that of the modified basic processes which are, with one exception, a combination of creosote and zinc chloride. The exception is the "Wellhouse" process, which is a combination of zinc chloride, tannin, and glue.

There are three processes which use a mixture of zinc chloride and creosote as a preservative, namely, the Rutgers, Allerdyce, and Card processes.

In the "Rutgers" process these two liquids are injected in a mixed condition, the object being to maintain a uniform mixture by regulating the gravities of the two liquids so that one will remain practically suspended in the other. This method, while still in use to some extent abroad, has had very little success in the United States, and the writer knows of no plant now operating under this process.

The "Allerdyce" process is a two-action process, the zinc chloride being injected first, and then the creosote oil.

In the "Card" process, which is practically new, having only been patented in March, 1906, the creosote is injected, mixed with the zinc chloride, the mixture being maintained under pressure by a centrifugal pump. This, of course, has the advantage over the Allerdyce process by reason of its being a one-movement process and, in addition, the oil is probably carried farther into the wood and is more evenly distributed.

These processes, undoubtedly, have considerable merit and will prove successful, providing the zinc chloride penetrates to the heart of the timber and the creosote sufficiently to act as a plug to prevent it from leaching out.

The heart wood of certain timbers seems to resist penetration by creosote alone, although it is susceptible of penetration by zinc chloride. The main objection to the injection of zinc chloride alone, is, as stated before, that the uses of timbers so treated are restricted, due to the fact that the zinc, being a soluble salt, soon leaches out. This objection is overcome if the leaching can be prevented, and to do this the creosote oil is injected.

There seems to be little question that this process is of more value than straight Burnettizing, but it is never claimed that it is as effective as straight creosoting. Its cost is slightly more than Burnettizing and slightly less than creosoting. For the preservation of railroad ties in properly selected territories, it is undoubtedly of great value.

In this paper the writer has endeavored to give a brief history of the development of wood preservation. He has abstained entirely from the use of figures in showing this development, and has attempted to bring out only those phases of the question which to him seemed to be important.

Vol. XXXVI. NOVEMBER, 1910. No. 9.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE VALUATION OF PUBLIC SERVICE CORPORATION PROPERTY.

By Henry Earle Riggs, M. Am. Soc. C. E.

To be Presented January 4th, 1911.

The industrial and economic development of the past two decades has opened many new lines of special work in the Profession of Engineering, none of which is more difficult and complicated or of greater ultimate value to the public at large than that of the appraisal or valuation of the property owned and operated by public service corporations; and none of the fields of engineering specialization requires greater care or calls for more skill, experience, integrity, or sound judgment.

The individual engineer, or commission of engineers, entering upon an appraisal of large magnitude, particularly one including properties of more than one company, will find conditions varying in every one, and each property presenting new, complex, and confusing elements of value to pass upon and determine.

Prior to 1900 there had been few calls on engineers for large appraisals, and the literature descriptive of engineering effort along this line was practically nothing. Since 1900 many extensive appraisals

---

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

have been undertaken by States, by railroad and banking corporations, and by cities; certain well-defined lines of practice have been developed; many differing opinions as to certain methods and principles have been brought out; and enough has been added to the printed literature to enable one to compare methods of work and to fix with reasonable certainty upon some as correct, and to discard others as improper.

There are so many complex factors entering into the problem of valuation, so many widely different plans have been presented, and there are so many thinking men who have opposed and do honestly and sincerely oppose any form of valuation, that a most thorough study of the subject should be made. It should be examined from all angles, and every possibility of danger from legislation regarding it should be weighed with utmost care.

The question of railroad valuation, involving as it does the largest industry of the nation, naturally takes first place in such a discussion, but so many of the general principles of railroad valuation are applicable to the appraisement of corporate property, so many arguments have been advanced by engineers and others, and so many judgments of the Courts have been rendered in connection with waterworks and gas-works valuations, that it is not desirable to limit this discussion wholly to the problem of railroad valuations.

The reasons for requiring that valuations be made may be broadly divided into two general classes:

First.—As a Matter of Public Interest.—The public, and particularly the investing public, requires valuations in order to guard against unworthy and dishonest corporation securities, to be assured that corporations are bearing their legitimate and proper share of the burden of taxation, and to furnish a proper basis for fixing equitable and just rates for the services rendered by the corporation.

Under this class would come all appraisals made for information to be used as a basis for legislation relative to:

(*a*) *Taxation of Corporations.*—Such were the valuations in Michigan and Wisconsin.

(*b*) *Rate Regulation.*—This was the reason which prompted the work in Minnesota and Nebraska.

(*c*) *Limitation of Capitalization.*—The regulation of issue of stocks and bonds was the purpose of the Texas valuation.

(*d*) *Fixing a Price for Sale.*—Many of the water-works and electric light valuations were made in order to determine a fair price to be paid for the property at the expiration of the franchise.

(*e*) *The General Information of the Public.*—To be used in connection with the fixing of terms for franchise renewals, etc., etc.

Second.—As a Matter of Corporation Necessity or Expediency.—Valuations are made in order to guide large investors, to secure a safe and up-to-date basis on which to negotiate a sale, a purchase, or a reorganization of the property, or a consolidation with other like properties, and to secure justice to honestly administered corporations.

The great majority of appraisals under this head have been in accordance with some other methods than those adopted in the State valuations. It is not intended in this paper to engage in any argument as to the various purposes of appraisals, or even to urge the necessity or desirability of a general appraisal of properties. An absolutely accurate and correct statement of the cost of reproduction of all the physical properties of the railroads of the country, a correct statement of the actual capital needed to reproduce these properties as they exist, and, along with this, a statement of the actual physical depreciation, would be a document of vital interest.

This paper is confined to a discussion of the methods which should be used in arriving at a correct figure of cost of reproduction and depreciation—it does not take up questions involving the propriety of those figures when reached. The propriety or legality of using such figures as a basis for an assessed valuation, as a basis for rate-making (rate-making being an art in itself involving complications as great as those encountered in valuation), or any arguments as to the justice or injustice of legislation restricting issues of stocks or bonds, will be conceded no place in this paper. It is assumed that all these questions would have been taken up and a satisfactory answer reached before a valuation could have been ordered.

The different elements of value in property, the relations of this property to the public, the method of determining the worth of these elements of value which have been adopted in the past by men engaged on valuation work, a comparison of these methods, a discussion of the objections that have been made to them, and a presentation, not only of the writer's views as to proper methods, but those in which he disagrees with usages adopted by others—these define the scope of this paper.

No matter what particular end is to be served by a valuation, the commission engaged upon it will be asked to furnish a fair value, perhaps with reasonable limitations in the instructions, perhaps with a general and indefinite instruction to find the value. They will encounter, among other difficulties:

First.—The fact that human machines are not exact duplicates, and that allowance must be made for a large measure of error, on account of the personal equation of the men engaged on the work, as individual errors of judgment are frequent on any work of magnitude. This personal element must be corrected by uniformity of method, by constant checking, and, as far as possible, by subordination of personality to system.

Second.—The fact that human selfishness is a dominant quality—the railroad manager who opposes methods which he believes will increase values in an appraisal for taxation, or who, on the other hand, uses every possible argument to increase values if the work be as a basis for rate-making or for restriction of bond issues, or the State official who is desirous of using original cost on a valuation to be used for rate-making in order to keep the valuation down to a minimum, and the politician who depends on an unenlightened public opinion to create sufficient outcry to influence the work to his advantage—are all actuated by a perfectly human wish to attain ends which seem to them desirable, and are but typical of men who will endeavor to influence every appraisal.

In view of these considerations, it is a question whether results are not frequently affected by the knowledge of their intended use, and whether a system which will entirely remove such causes of error can be applied to the work.

If an engineer, or a commission of engineers, is directed to examine a certain property and report the true cost of reproduction, depreciation, or present value, taking into account all facts connected therewith, the final figures should not differ, whether the report is to be used as a basis for reorganization, sale to another corporation, or is to be used by a State legislature as a basis for formulating a rate bill, or as a basis for a value for taxation. The result secured is a necessary preliminary on which depends the accuracy, fairness, and justice of the other work which is to follow. This is an engineering work, a statement of certain physical property, the estimated cost of reproducing it new, less the estimated depreciation, and, beyond the differences due to personal judgment, these figures may not vary.

The word "value" is in common use, and yet, in the minds of many people, its exact meaning is vague. It is true that the "value" of a property is an unstable figure, subject to fluctuations due to natural or artificial causes, and that a material change in value may occur suddenly, but the "value" of any given property on any given date is, or should be, from an engineering standpoint, a definite sum which may not be varied or changed to suit the whim or will of the people for whom the work is done.

In all the subsequent discussion of values and methods of obtaining values, it is assumed that, unless specifically limited to a determination of cost of reproduction and depreciation, a valuation commission should be governed by the following rules:

1.—No account may be taken of the purpose for which the resultant figure of value is to be used; and the result should not vary, no matter what that purpose may be.

2.—The resultant figure should be the honest judgment of the men composing the commission, as to the actual cost of reproduction, present physical value, or "fair value," and should be ascertained by a systematic and scientific method which takes into account all the facts concerning the property, its physical value, its strategic location, its operating revenues and expenses, and its franchises, rights, competition, opposition, and all other tangible or intangible elements which would affect values. The method of valuation should be such as to minimize or entirely eliminate all differences due to errors of personal judgment.

3.—All properties being appraised are considered as operating properties. One which is dead, inert, and not in use, cannot be considered as coming under such a discussion as this, and such properties are not treated in this paper. The term "going concern" is not used in connection with the physical property, any element of value implied by the term, over and above the "overhead charges," being treated as an intangible or non-physical element of value.

In stating this position, the writer is aware that it is a difficult matter indeed to get away from the fact that some specific purpose—taxation, for example—is the definite end in view in every valuation, and that, instinctively, men engaged on the appraisal will find themselves modifying their figures to meet some real or fancied condition which they conceive might arise, or to prevent some injustice which they believe might be done. Every subordinate employee needs to be watched, every man in charge must watch himself, or he will find himself unwittingly, almost instinctively, coloring his results by some old prejudice of his early years of employment, or some loyalty to his own ideas of governmental or economic policy. The writer has noted this in every appraisal on which he has been engaged, and calls particular attention to it as the first difficulty which must be overcome in the organization of the force for a large appraisal.

In the following pages all complications which might arise from the purpose of the appraisement are considered as eliminated, and the possibility of erroneous conclusions being reached by reason of the personal factor (while recognized as being ever present) will not be specially emphasized.

The Relation of Public Service, or Quasi-Public Corporations, to the People.

In reference to questions of value, the engineering commission must hear, consider, and reconcile arguments advanced by adverse and often hostile interests. On the one side stand the corporations, with large financial interests involved, often with an excessive amount of stock and bonds issued on the property, the existence of which issues the corporation wishes to justify, and, whether properly capitalized or not, the management being imbued with the perfectly human desire to defend corporate interests from attack of any kind; on the other side is public opinion, often unreasonable, often misinformed, and frequently prejudiced.

It appears necessary, therefore, to consider briefly the relation which these interests bear to one another, to study the causes which have led to mutual misunderstandings, and to note the proper relations which should, if possible, be established and maintained between the people and those corporations organized to perform certain of the functions of the State.

A public service or quasi-public corporation is a corporation which is operating under the terms of rights, grants, or franchises given by the public either to this particular corporation direct or granted by statute to a class of corporations.

The property of the corporation is used to render certain services to the public, with the expectation of financial gain.

It is not material whether the grant be a franchise permitting a water-works company to use the streets and alleys of a city for its mains, and the service be the pumping of water for domestic service and fire protection, or whether the grant be the statutory rights of corporate existence and eminent domain, and the service rendered be the transportation of freight and passengers, the general principle is the same; the company has secured from the people certain rights which enable it to do business, and the people are directly benefited by the services rendered by the company. The increased comfort of living makes for the growth of the city; the increased transportation facilities build and develop the country traversed by the railroad, and this growth and development, not only operate to the advantage of the people, but also to that of the company in the way of increased business and increased revenues.

The capital required to build and develop these properties was furnished in the hope of, and with the expectation of, a proper financial reward. It has frequently happened that such properties have been built years in advance of sufficient development to support the enterprise, built, in fact, without expectation of immediate returns, and long periods of time have often elapsed before any profit has been secured.

It has also frequently happened that corporations have been aided to a very large extent by public funds, by the voting of aid bonds, by the donation of large tracts of land, by payment for certain service at such rates as would largely relieve the company from loss in operation, by the remission of taxes, or by the direct donation of funds.

The company is clearly entitled to earn a reasonable profit on the actual capital invested, in addition to the legitimate cost of operation, payment of taxes, and sinking funds to cover depreciation and obsolescence.

The public is clearly entitled to good service at the lowest rates that will permit the company to earn its reasonable profit and expenses. Increases in tonnage, population, and consequent net earnings of the corporation should entitle the public to a benefit in reduced charges for service, when the increased earning is of a permanent character.

The general tendency of the Courts has been to treat a franchise as a contract, and to be governed closely by the language and evident intent of the makers, but to safeguard the rights of the public to the fullest extent consistent with justice.

A franchise requires specific performance of specific acts. Nothing will be assumed or implied. The Courts recognize that the investors are entitled to reasonable returns, and that the public is entitled to fair rates.

In the case of Los Angeles Water Company *vs.* City of Los Angeles (103 U. S., 711), the United States Courts held that at the expiration of a 30-year franchise, which provided that the city was to pay for the value of all improvements, when the city failed to agree upon, tender, or pay such value, so long as the company complied with the terms of the contract, and until the city terminated it by making or tendering payment, the passage of an ordinance by the city fixing rates was void.

In the case of Weatherly *vs.* Capital City Water Company (Ala. 22 So., 140), the Alabama Courts held that the acceptance of a franchise involved a grave responsibility, and that the company could not stop furnishing water and fire protection, even if the work was done at a loss.

In the case of Myer *vs.* Brown (65 Cal., 589), the Court said:

"It is well occasionally to recall the fact that there is no more reason to permit a municipal government to repudiate its obligations entered into for value, than to permit an individual to do so. Good faith and fair dealing should be exacted of one equally with the other."

Judge Brewer, in the Kansas City Water-Works case (62 Fed. Rep., 853), said:

"All contracts involving property rights and obligations, between municipalities and individuals, must be presumed to be based upon and to recognize the ordinary laws of business transactions."

In 1903 the Maine Supreme Court issued a set of instructions to appraisers appointed to fix values of certain properties. The Court set forth its views as follows:

"Summarized, these elemental principles are, the right of the company to derive a fair income based upon the fair value of the property at the time it is being used for the public, taking into account the cost of maintenance and depreciation and the current operating expenses, and the right of the public to demand that the rates shall be no higher than the services are worth to them, not in the aggregate, but as individuals."

The Supreme Court of the United States has again and again given its views, which may be summarized as follows:

"It cannot be said that a corporation is entitled, as of right, without reference to the interests of the public, to realize a given per cent. upon its capital stock. When a question arises whether the legislature has exceeded its constitutional powers in prescribing rates to be charged by a corporation controlling a public highway, stockholders are not the only persons whose rights and interests are to be considered. The rights of the public are not to be ignored.

* * * * * * *

"The public cannot properly be subjected to unreasonable rates in order simply that stockholders may earn dividends. The legislature has the authority in every case, where its power has not been restrained by contract, to proceed upon the ground that the public may not rightfully be required to submit to unreasonable exactions for the use of a public highway established and maintained under legislative authority." (164 U. S., 578.)

"It is not to be inferred that the power of limitation or regulation is itself without limit. This power to regulate is not a power to destroy, and limitation is not the equivalent of confiscation. Under pretense of regulating fares and freights the State cannot require a railroad corporation to carry persons or property without reward, neither can it do that which in law amounts to the taking of private property for public use without just compensation. * * *" (116 U. S., 307.)

In the case of Smyth *vs.* Ames (169 U. S., 466), the Court said:

"If a railroad corporation has bonded its property for an amount that exceeds its fair value, or if its capitalization is largely fictitious, it may not impose upon the public the burden of such increased rates as may be required for the purpose of realizing profits upon such excessive valuation or fictitious capitalizations; and the apparent value of the property and franchises used by the corporations, as represented by its stocks, bonds and obligations, is not alone to be considered when determining the rates that may reasonably be charged. * * *

"We hold, however, that the basis of all calculations as to the reasonableness of rates to be charged by a corporation maintaining a highway under legislative sanction must be the fair value of the property being used by it for the convenience of the public.

* * * * * * *

"What the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience. On the other hand, what the public is entitled to demand is that no more be exacted from it for the use of a public highway than the services rendered by it are reasonably worth."

The relations between the corporations and the public that they serve have been clearly defined by the Courts, as the foregoing quotations show.

That the mutual relations existing between the management of the corporations and the public are far from what they should be, there can be no doubt. On the one hand, the great mass of the voting public is uninformed as to actual revenues, disbursements, and operations of the corporations, as to whether their income is unreasonably large, or whether they are struggling to exist. The sums of money involved in the dealings of the corporations are so stupendous in comparison with the amounts used in an ordinary private business—even in one of considerable magnitude—that the majority of the public cannot comprehend them. The published statistics are in such form that only the careful student of affairs can understand or analyze them, and but few of the public officials who receive them are able to read the reports of the properties and comprehend them. As a consequence, the corporation, as a political issue, has been the subject of jest, gibe, and cartoon; there has not been an intelligent public discussion of available reports and statistics, and it may be said that, generally, the mass of the public has come to class all corporations as grasping, overbearing, and unjust, and to consider them all as exceedingly prosperous. This has been taken advantage of by politicians for their own selfish ends, and has led to sundry legislation, some of which has been unreasonable and unjust to the corporations, and much of which is aimed at real abuses that never ought to have existed.

The reasonableness of a rate depends, not alone on the amount of capital invested, but on the volume of traffic, the density of population, the actual cost of service, and many other elements. Rate legislation has been attempted without full investigation. Acts have been passed compelling the establishment of stations and terminals, the improvement of roadway and structures, the purchase of new equipment, the installation of safety appliances and block signals, and many other requirements have been made, some (but by no means all) of which are unreasonable and burdensome. Nearly one-half the States of the Union have by law required a 2-cent, or 2½-cent, passenger fare, regardless of density of population, amount of traffic, or other considerations which might render such rates unreasonable. The regulation of the carriers, by legislature, by railroad commissions, by State officials, and by Courts, the addition of burdens of expense, and the cutting off of revenue, all give considerable ground for the opposition of the carriers to anything that looks like hostile legislation, and compels the student of affairs to admit that there is justice in the claim of the managements, that there is grave danger, not only of seriously crippling many roads, but of so impairing the credit of the railroads as a class that it will be increasingly difficult to secure capital to provide for the necessary extensions and development of the transportation facilities of the country.

On the other hand, perfect frankness compels the admission that the state of public opinion which compelled the passage of these laws has been caused largely by the corporation officials themselves. There is probably no more loyal body of men in America to-day than the officials and employees of railroads. Their loyalty, however, is all to "our company." They enter its service as boys or young men; they grow up to the full strength of manhood working for its good; they take little or no part in public affairs; they have no time for the study of public questions. Their friends are almost exclusively among their own associates in the service of the road, and their development is along the lines of their own special work in the service. As a body of honest, honorable, and worthy men, absolutely loyal to their employers, they have few equals; but it is doubtful if any equal number of men, of equal intelligence, have as limited a knowledge of the fundamental truths of government, or knowledge so colored by bias. It is also doubtful whether any equal number of men have in their ranks so few who bear an active part in the duties and activities of citizenship, or who exercise large influence on their neighbors.

While the foregoing statement is believed to be absolutely true, it will not do to pass over the notable exceptions. Such men as James J. Hill, F. Am. Soc. C. E., M. E. Ingalls, and others of the higher officials, who have taken an active part in public affairs, have had commanding influence. Theirs has been the sound policy, as the property in their hands has not suffered. The short-sighted policy which, in December, 1909, induced the management of one road to compel all its employees holding municipal offices to resign, is bound to react and create hostile feeling on the part of the public.

The entire trend of a training in railway service is to fill a man with prejudice against all things that undertake to regulate or control the corporations, and often goes so far as to enable him to do, willingly and as a matter of right, things which with a broader view of the interest of the whole community he would not agree with at all. The result of this intensive training is that the railway service has in it thousands of men who become impatient with any effort to regulate or control; who permit their irritation to show; and who, by their own attitude, create unnecessary hostility. F. A. Delano, M. Am. Soc. C. E., President of the Wabash, in an address* at Hannibal, Mo., on March 25th, 1909, said:

> "In ordinary manufacturing or commercial undertakings, every man has his own notions about the conduct of his business, and does not want to be interfered with, or dictated to by people who know less about his business than he does himself. Now, while it may be argued in the case of public service corporations that the people who have put their money into these enterprises, have done it with their eyes open and with full knowledge that they were subject to governmental regulation and control, there is nothing in that argument which makes public interference any more palatable to the man or group of men who are interfered with."

This address well expresses the spirit of the railway managers and employees toward all forms of investigation, and the complete lack of understanding, on the part of these managers, of the legal and moral relations which they bear to the communities which they serve. It is extremely unfortunate that railway and corporation people have not taken the public fully into their confidence, and fully and freely given out correct information as to the operation and depreciation of their properties; also, it is unfortunate that, when a corporation official does feel a grievance, he permits himself to make a partisan speech, or write an unwise article for publication. Much hostility is traceable to foolish, undiplomatic sayings or writings of corporation managers (which are often but half quoted), or to equally foolish speeches or newspaper editorials in opposition to the corporations, which are taken seriously by the managers. Whatever may be the cause, there is a regrettable hostility, and, on the part of the corporation officials, there is an apparent unwillingness to admit right motives to anyone advancing theories regarding corporate regulation and control, due largely to the training and atmosphere surrounding the corporate service.

---

* *Railroad Age Gazette*, April 16th, 1909, p. 857.

The public has a large bill of particulars, one of which is the promotion of wildcat companies, such, for instance, as the "New York and Chicago Air Line" project which, only a year or so ago, drew from $2 000 000 to $3 000 000 from the people in a limited territory. These people were "investing" in railway stocks. A Federal control of the issue of stocks and bonds would have prevented this and hundreds of like swindles. Any move to secure such a law has always been opposed by the management of large and legitimately operated corporations, under the impression that they are about to be persecuted, and, naturally, the victim classes these corporations with the alleged one that secured his money.

The issue of stocks and bonds far in excess of any possible cost or value of railroad, street railroad, and other properties, and the making of large personal fortunes by the promoters, are matters of such frequent occurrence that it is difficult, indeed, to dismiss them with a mere denial. There is hardly a community of any size which has not had its example of "consolidation," "combine," or "merger," which has resulted in the issue of excessive securities; and there is hardly a citizen of any intelligence who has not either seen or had experience with some form of corporation promotion carried on strictly within the law, but which, nevertheless, in plain language, was a swindle. These, to say nothing of some gigantic deals involving millions, will sooner or later compel some form of regulation of the issues of stocks and bonds. In the last analysis, it is the money of the people, the hundreds of thousands of small investors, depositors in banks, and owners of life insurance, whose money goes into corporation securities, and, until the officers of the great railroads co-operate in securing such forms of control of stock and bond issues as will make impossible the purely speculative "wildcat" corporations, and thus safeguard minor corporations, as to furnish at least reasonable security to those whose money is invested, all forms of corporation security must be under suspicion with the public, and the agitation for control must continue.

It is not, as Mr. Delano says, a case of put your money in with your eyes wide open; it is an effort on the part of the people to safeguard this form of corporate security in such a way that it can be treated as any other form of sound investment. It should not be necessary to require that all investors in corporate securities be financial experts. It is the writer's opinion, based on his observation and professional practice, that the railroads are not generally open to charges of over-capitalization. While there are flagrant instances, the chief culprits are among other classes of corporations. If such be the fact, it would seem that the interests of the great railway corporations would be in no wise jeopardized by sane and reasonable control.

The theory of taxation is that every one shall bear his proportionate burden of the cost of maintaining the government.

Regardless of any opinions that may be held as to the propriety of the methods adopted in the Interstate Commerce Commission's commercial valuation of railroad properties, it will be conceded that the results gave a set of figures for all the States of the Union, secured by a uniform method of computation and distribution. Table 1, which is a compilation from Tables 1 to 11 of Bulletin 21, shows clearly why, in certain States, corporate taxation is a live issue, and if (as suggested by Mr. Williams in his article, elsewhere referred to) amendment of the Constitutions of some of the States is necessary, it is safe to assume that the condition of inequality shown by this table is such as to compel these changes.

It is needless to cite further instances; enough has been said to indicate:

First.—That the corporations and the public have such intimate business relations that a blow at either must necessarily injure the other seriously;

Second.—That the Courts have defined quite clearly the legal relation existing between the two interests;

Third.—That there is lacking a proper spirit of mutual confidence, and the two interests at the present time are generally hostile;

Fourth.—That there have been errors and abuses on the part of both corporations and public; and

Fifth.—That capital invested in corporations is, and should be, the money of the people, and should be safeguarded so as to prevent its loss by manipulation, and insure a fair return.

TABLE 1.—COMPARISON OF ASSESSED VALUATION AND COMMERCIAL VALUE OF RAILWAY PROPERTIES.

State or territory.	Miles of single track.	Commercial value: June 30th, 1904.	VALUATION FOR ASSESSMENT.		Ratio of assessed to commercial valuation: Percentage.
			Year.	Amount.	
Alabama	4 669.35	$150 211 000	1905	$53 926 026	35.9
Arkansas	4 126.44	124 626 000	1904	34 709 623	27.8
California	6 262.54	350 694 000	1904	92 378 550	26.3
Colorado	4 976.24	198 261 000	1903	49 492 135	25.0
Connecticut	1 017.72	105 369 000	1904	120 493 648	114.4
Florida	3 555.84	80 467 000	1904	21 817 478	27.1
Georgia	6 304.72	156 603 000	1903	63 105 810	40.3
Idaho	1 461.53	91 877 000	1904	10 115 378	11.0
Illinois	11 622.74	805 057 000	1904	425 709 055	63.8
Indiana	6 917.85	375 541 000	1904	165 863 367	44.2
Iowa	9 859.23	344 847 000	1904	57 535 160	16.7
Kansas	8 811.43	356 356 000	1904	60 093 534	16.9
Kentucky	3 253.00	155 772 000	1904	77 658 040	49.9
Louisiana	3 898.74	123 401 000	1904	29 044 195	28.9
Michigan	8 660.29	277 597 000	1904	196 795 000	70.9
Minnesota	7 811.04	466 734 000	....	....	....
Mississippi	3 480.25	107 884 000	1902	29 847 640	27.7
Missouri	7 711.05	309 768 000	1903	97 916 869	31.6
Montana	3 267.10	196 209 000	1904	36 759 827	18.7
Nebraska	5 820.88	263 170 000	1904	46 082 853	18.5
Nevada	986.56	43 745 000	1904	13 778 049	31.5
New Hampshire	1 275.97	79 786 000	1904	22 625 000	28.3
New Jersey	2 277.85	333 568 000	1904	231 655 525	69.5
New York	8 297.29	898 222 000	1903	229 582 064	25.6
North Carolina	4 075.00	113 146 000	1904	69 480 974	61.4
North Dakota	3 190.77	123 390 000	1904	22 160 304	18.0
Ohio	9 196.88	689 797 000	1904	133 858 945	19.4
Oklahoma	2 611.03	78 668 000	1905	11 936 317	15.2
Pennsylvania	11 023.24	1 420 680 000	....	....	....
Rhode Island	211.89	25 719 000	1904	15 832 003	61.6
South Carolina	3 175.28	75 500 000	1903	29 467 716	39.0
South Dakota	3 047.14	49 646 000	1904	14 354 930	28.9
Tennessee	3 480.83	131 166 000	1903	58 536 566	46.6
Texas	11 848.03	237 718 000	1904	95 209 785	40.0
Utah	1 779.69	90 325 000	1904	20 682 461	22.9
Vermont	1 063.25	37 311 000	1902	27 344 020	73.3
Virginia	3 932.33	211 315 000	1904	63 269 623	37.7
West Virginia	2 836.83	201 799 000	1904	28 771 358	14.2
Washington	3 355.83	182 837 000	1904	26 066 949	14.3
Wisconsin	7 048.76	284 510 000	1904	218 024 900	76.6
Wyoming	1 247.70	100 307 000	1904	7 498 232	7.5
Arizona	1 751.35	68 356 000	1904	6 667 349	9.7
District of Columbia	32.00	5 578 000	1904	2 486 024	44.6
New Mexico	2 504.66	8 640 000	1904	8 511 538	9.9
Total, U. S. A.	213 932.13	$11 244 852 000	....	....	....

In concluding this subject, it may not be amiss to quote the language of the Supreme Court in the Knoxville Water Case (212 U. S., 1), as follows:

"Regulation of public service corporations, which perform their duties under conditions of necessary monopoly, will occur with greater and greater frequency as time goes on. It is a delicate and dangerous function, and ought to be exercised with a keen sense of justice on the part of the regulating body, met by a frank disclosure on the part of the company to be regulated. The Courts ought not to bear the whole burden of saving property from confiscation, though they will not be found wanting when the proof is clear.

"The legislatures and subordinate bodies to whom the legislative power has been delegated ought to do their part. Our social system rests largely upon the sanctity of private property, and that State or community which seeks to invade it will soon discover the error, in the disaster that follows. The slight gain to the consumer, which he would obtain from a reduction in the rates charged by Public Service Corporations, is as nothing compared with his share in the ruin which would be brought about by denying to private property its just reward, thus unsettling values and destroying confidence. On the other hand, the companies to be regulated will find it to their lasting interest to furnish freely the information upon which a just regulation can be based."

EXPLANATION OF TERMS.

In order that there may be no doubt as to the exact meaning of the terms used throughout this paper, a few definitions or explanations are submitted:

Appraisal, or Valuation.—These words are used interchangeably, and refer to the engineering work of determining the present worth of both physical and intangible properties of corporations.

Cost of Reproduction.—This expression refers to the estimate of cost of reproducing the physical properties as they exist on the date of the appraisal, all elements entering into the cost being considered as new and not affected by the elements of depreciation or obsolescence.

Cost, or Original Cost.—These terms refer to the actual amount of money paid for the property, either when it was originally constructed, or in its condition at the time of appraisal, the latter case being the original cost plus the cost of additions and betterments, less abandoned, replaced, or worn-out property. This figure ought to be represented by the "book cost," but it is not often that "book cost" and "actual cost" are the same.

Present Value, or Present Physical Value.—These terms are used in describing the physical property as reproduced after it is affected by all elements of depreciation or appreciation. The use of the word "value" in this expression is unfortunate, as it may lead to some confusion. It must be kept clearly in mind that, where this term is used, it refers only to physical property as depreciated, and is in no case intended to refer to the final or "fair value" of the property.

Non-physical, or Intangible, Value.—These terms are used to represent those elements, entering into the final worth of the property as a business concern, which arise out of the operation of the property and are not attachable to the physical property.

All the foregoing terms have to do with the determination of the elements which enter into the final value.

What is "value"? In defining the exact meaning of this term, as applied to the property of a public service corporation, many elements must be taken into account. Standard authorities give many definitions of "value," none of which appears to meet fully the requirements of the term as used herein. Before considering the elements which enter into the value of corporation property, or attempting to determine the methods to be used in fixing proper figures of worth for each of these elements, it is proper and necessary to obtain a clear definition of "value," the thing sought to be ascertained by the inquiry.

The term, "commercial value," has been considered in place of "value," but is not used because it is held to be more properly applicable to the selling or exchanging value of fractional interests in the property, and the methods of computing the commercial value of securities which are in common use cannot be adopted in an engineering valuation. The Standard Dictionary definition of "commercial value" is:

"The source of commercial value, according to different schools of economists, is (1) the degree of want felt for a commodity as shown in the relation of supply and demand, (2) the amount of labor embodied in it, or (3) the cost of reproduction. Practically, commercial value is that for which a thing can be sold or exchanged at a given time and place."

The definition given by Professor Adams is:

"The estimate placed upon the worth of a property, regarded as a business proposition."

Both these definitions are in a measure involved, and the writer considers that the term, "Commercial Value," is too narrow and restricted to be properly used.

As a definition of that estimate of worth which an engineering commission should report as the result of a complete appraisal, the writer submits the following:

The value of a property is its estimated worth at a given time, measured in money, taking into account all the elements which add to its usefulness or desirability as a business or profit-earning proposition.

There are two classes of elements entering into the final value:

(1) *The "Physical Property" Element of Value.*—This consisted of those things which are visible and tangible, capable of being inventoried, their cost of reproduction determined, their depreciation measured, and without which the property would be unable to produce the commodity on the sale of which income depends. This physical property is considered as an operating entity, and not as collateral of inert and partly worn-out equipment, and, being so considered, carries, as part of the physical value, those costs and charges which are an inseparable part of the cost of construction but do not appear in the inventory of the completed property.

(2) *The "Non-Physical" or "Intangible" Elements of Value.*—These are those things which, added to or taken from the worth of the physical property, make up the value, and include whatever accrues to the property by reason of its operation, or by reason of grants, contract rights, competition, or location, which at the time of appraisal affect favorably or unfavorably the worth of the property.

The worth of the physical property is primarily that on which the value of the whole property rests.

While it is clear that the worth of the physical property, being the cost of reproduction less depreciation, is not necessarily the value of the property, it is equally clear that the physical worth must bear some very definite relation to value, and the writer is strongly of the conviction that this relation is such that "value" cannot be ascertained without a determination of physical worth. The physical property element represents the investment on which a fair return is to be earned, and in most cases an appraisal is necessary for the determination of the amount of money actually invested. As illustration of the fact that "physical value" and "value" are not the same, the case of two railroads actually existing and in operation between two cities in Michigan may be cited.

Road "A" occupies a narrow valley through high and abrupt hills. Its alignment is fair for hilly country; its maximum grade is 1 per cent. It has a number of bridges, all short and low. Its cost of reproduction might reasonably be placed at $28 000 per mile. A mining town at one end ships a heavy tonnage down grade to a lake port at the other.

Road "B" was constructed several years later, and, being barred from the only valley, built a line across the hills, involving heavy grading, very long and high steel trestles, a longer line, maximum grades of 2%, and a heavy climb from the mining town to the summit before starting to drop to the lake. The cost of construction was more than double that of Line "A," and the tonnage which can be hauled in either direction is but a small fraction of that which can be hauled with the same power by Road "A." A reasonable figure for cost of reproduction may be given as $60 000 per mile.

Here is clearly a case where the older, less expensively built road has a value as an earning proposition far in excess of that of the new road. The rate on commodities does not affect the relative difference. A higher rate, while permitting Road "B" to live, greatly adds to the value of Road "A," while the latter can operate at a profit on rates which would not permit Road "B" to pay expenses.

This example indicates the existence of non-physical values, not only positive in the case of Road "A," but also negative as to Road "B."

Many properties have been built in the United States, representing large investments of capital, which are not, and some of which can never be, profitable business investments. In all such the physical valuation will exceed the final value where the property is considered as an operating concern, and a negative factor to cover improper location, uneconomical design, ill-advised investment, or whatever the trouble may be, should be applied.

The physical property is that which enables the corporation to do business. Without physical property it could not produce the commodity which it sells. The amount of money actually invested in acquiring that physical property represents the measure of capital on which it is morally entitled to earn interest and profit; and, in the stage of promoting and financing the enterprise, all hope of earnings is based on the amount of money required to construct the property. These considerations lead the writer to contend that the true method of valuing a corporate property is first to determine the cost of reproduction of the property and its depreciation, and modify this figure by any applicable positive or negative non-physical elements of value.

THE MICHIGAN STATE APPRAISALS.

Organization.

The State Legislature of Michigan, at the session of 1899, passed an act creating a Board of State Tax Commissioners and outlining and prescribing their duties. This act authorized the board to "inquire into and ascertain the value of the property of corporations paying specific taxes under any of the laws of this State."

The object of this valuation was to determine the rate at which the corporations were paying taxes, to the end that necessary laws should be passed so that all taxable properties in the State might be taxed uniformly.

On September 1st, 1900, the Board of Tax Commissioners appointed Professor Mortimer E. Cooley Appraiser of Properties. Immediately thereafter the general organization was mapped out along the following lines of division of labor and responsibility:

1.—Administration.—All matters of general policy in regard to the conduct of the work, all matters relating to negotiations and conferences with officials of corporations, all transactions with the State Tax Commission, the Governor, or the Board of State Auditors, and the entire direction of all relations with the public through newspapers and other channels, were retained by the appraiser, who was the final arbiter on all matters referred to him regarding the details of the work.

2.—Civil Engineering.—The appraisal of all property which in the course of construction would fall under the supervision of the civil engineering department of a road, including land, roadway, bridges, and structures, was in charge of the writer.

3.—Mechanical Engineering.—The appraisal of all motive power, rolling stock, and property which in the course of construction would fall under the supervision of the mechanical engineer, including power and electric plants, shop tools and machinery, water stations, etc., was in charge of Mr. Theodore H. Hinchman, Jr., of Detroit, Mich.

In the matter of the final assembling of figures, computation of percentage values, and compilation of final results, Mr. Hinchman and the writer worked together with joint general supervision.

4.—Telegraphs.—The inspection and appraisal of all telegraph properties was under charge of Mr. William S. Conant, of Detroit, Mich.

5.—Telephones.—The appraisal of all telephone properties was directed by Mr. William J. Rice, of New York.

6.—Vessel Properties.—All vessels belonging to companies whose property was involved by the appraisal were inspected and appraised by Herbert C. Sadler, Professor of Naval Architecture and Marine Engineering at the University of Michigan.

In the following narrative, no special mention is made of the work executed under the direction of Messrs. Conant, Rice, and Sadler, because they really had charge of independent appraisals which were conducted on lines similar to those adopted in the railroad appraisal, and their methods were not different from those of the latter; hence any description of their work would be in a large measure repetition. This omission is in no wise to be construed as any reflection on the importance or high character of their work.

The organization as just outlined, while necessarily touching and overlapping at points, was generally defined so clearly that there was no duplication of work. Each head of department was responsible for the work of his special division, and directed the laying out and execution of the work done by his men.

The first task, after deciding on the general organization, was to determine the general methods to be adopted and the manner of getting the necessary detailed information. The magnitude of the work was appalling. There were seventy-eight different incorporated companies, owning some 10 000 miles of railroad, scattered over 54 000 sq. miles of territory. In addition, there were a number of small unincorporated railroads, telegraph, telephone, plank road, and other corporations, many of which had no records, no complete inventory, and no department organized so that the information could be readily secured. It was determined:

(*1*) To make or secure a complete detailed inventory of every piece or parcel of property belonging to each company;

(*2*) To examine each separate thing, place on it an estimate of cost of reproduction and depreciation;

(*3*) To prepare, as a basis for the final figure of value, an estimate of the present value, being the cost of reproduction less the depreciation.

Having determined on a detailed physical inventory and appraisal, the next step was to outline the work so as to secure absolute uniformity. The difficulties which confronted the appraiser at this period were many, chief among which were:

(*a*) *Lack of Complete Understanding on the Part of the State Officials.*—The Governor and Board of Tax Commissioners rendered every possible assistance, but the Board of State Auditors was not at first fully committed to the work, and the uncertainty as to whether or not bills would be paid, delayed seriously the employment of men and the full commencement of work for 3 or 4 weeks after the first organization was made.

(*b*) *The Attitude of the Railroad Corporation Managers.*—While this was not actively hostile, it was a serious cause of delay, as they could not foresee what effect the work might have on the interests in their charge, and, while not refusing access to their records, they delayed and held back information; in fact, a long time elapsed before all the companies opened their records to the appraiser and his staff.

(*c*) *The Confused Condition of the Records.*—Many small corporations had absolutely nothing in the way of records of buildings, bridges, land, or other properties. Others had very complete records in certain departments and very imperfect ones in others; still others had records which had every appearance of being complete, but they were not up-to-date.

Facing an appraisal of this magnitude, with a time limit of only 4 months for the entire work, with delays at the outset which seriously hampered the organization for 2 or 3 weeks, the appraiser was compelled to occupy this time in preparing the blank forms to be used on the work, and in conducting correspondence with the men who were to make up the working force, investigating their references, etc.

The blank forms, Figs. 1 to 10, were the result of a series of conferences between the members of the staff. By this time it was quite evident that no great amount of help could be hoped for from the corporations. Had it been possible to secure access to the records of such railroad companies as the Michigan Central or the Lake Shore and Michigan Southern before the final drafts of the forms were prepared, the writer believes that several might have been simplified and many improvements could have been made. However, this was not possible, and the forms were prepared and printed before access to any railroad office had been granted.

T. C. Form R.R. 9

MICHIGAN RAILROAD APPRAISAL

__________Railroad

Date __________

ALIGNMENT AND PROFILE IN MICHIGAN

__________ *Office Inspector*

__________ *Field Inspector*

DIVISIONS OF ROAD		ALIGNMENT							PROFILE					
FROM	TO	Length Miles	Number of Curves	Aggregate Length of Curved Line Miles	Aggregate Length of Straight-Line Miles	Number of Curves over 3 Degrees	Total Curvature over 3 Degrees	What is Degree of Maximum Curves	Aggregate Length of Level Grades	Sum of Ascents Feet	Sum of Descents Feet	Number of Miles Grade 0.5% to 1%	Number of Miles Grade Over 1%	What is rate Your Maximum Grades and what their length Miles

T. C. Form R.R. 4

MICHIGAN RAILROAD APPRAISAL

__________Railroad.

Date __________

RIGHT OF WAY AND REAL ESTATE

IN FILLING OUT STATEMENT KINDLY SEPARATE LANDS AND RIGHT OF WAY BY COUNTIES AS FAR AS POSSIBLE

__________ *Office Inspector*

__________ *Field Inspector*

COUNTY	Trackage Right only Miles	WIDTH OF RIGHT OF WAY IN FEET						Total Acreage of Right of Way	Total Acreage Lands own'd by Company other than Right of Way	TOTAL REAL ESTATE	
		Less than 50 Miles	50 to 60 Miles	60 to 70 Miles	70 to 99 Miles	100 Miles	Over 100 Miles				

T.C. Form R.R. 3

MICHIGAN RAILROAD APPRAISAL

__________Railroad

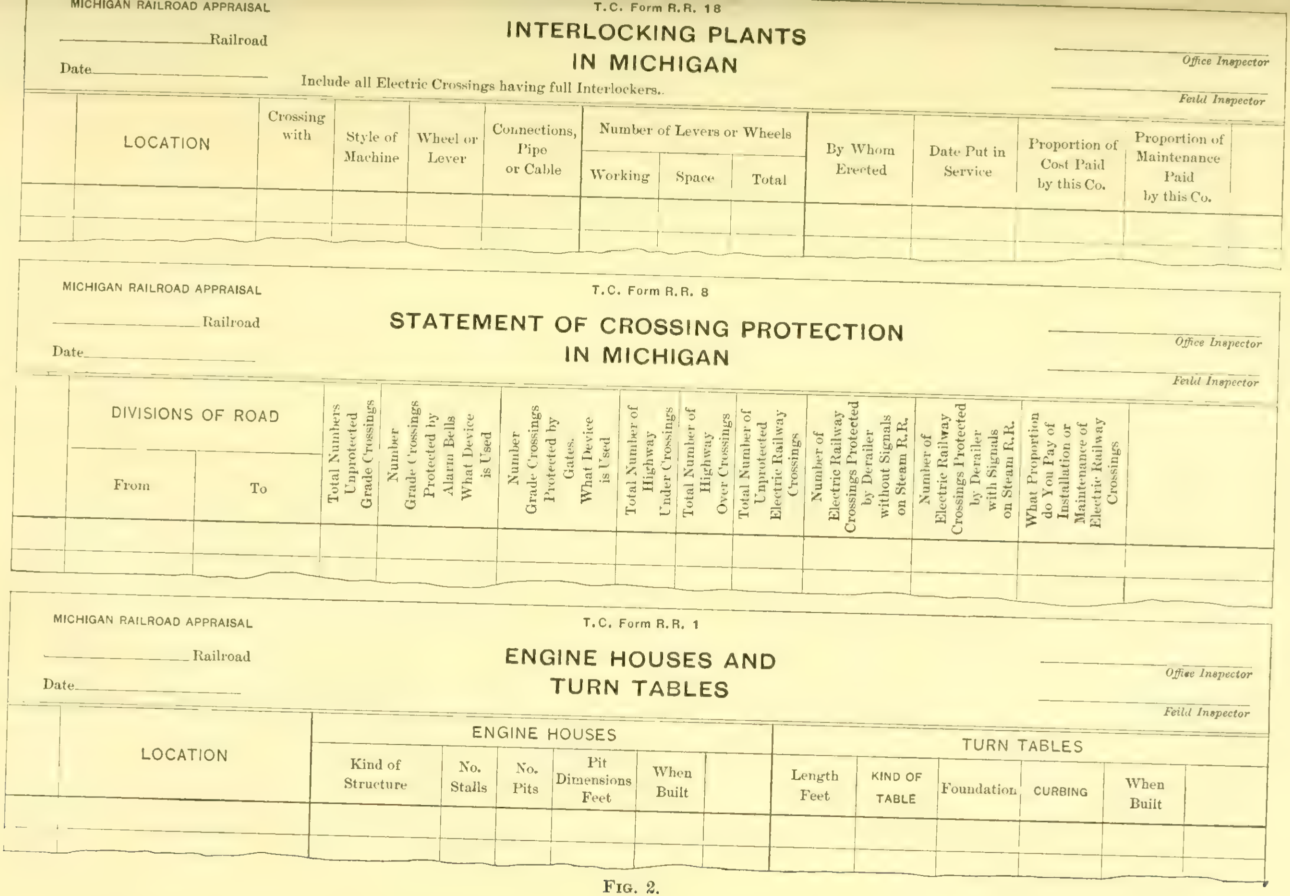
Date __________

MILEAGE, RAIL AND TIES

__________ *Office Inspector*

__________ *Field Inspector*

		Total Length in Miles	Total Number of Side Tracks or Spurs	Yard Tracks Miles	Double Track Miles	Rail under 40 lbs. per yard Miles	Rail 40 to 49 lbs. per yard Miles	Rail 50 to 59 lbs. per yard Miles	Rail 60 to 69 lbs. per yard Miles	Rail 70 to 79 lbs. per yard Miles	Rail 80 to 89 lbs. per yard Miles	Rail 90 to 100 lbs. per yard Miles	Rail over 100 lbs. per yard Miles	Number of Ties per mile	Percentage of Oak Ties	Percentage of Cedar Ties	Percentage of Hemlock Ties	Percentage of other Ties
Main Track from " " "	to "																	



MICHIGAN RAILROAD APPRAISAL

T.C. Form R.R. 18

______Railroad

Date______

INTERLOCKING PLANTS IN MICHIGAN

Include all Electric Crossings having full Interlockers.

______*Office Inspector*

______*Feild Inspector*

	LOCATION	Crossing with	Style of Machine	Wheel or Lever	Connections, Pipe or Cable	Number of Levers or Wheels			By Whom Erected	Date Put in Service	Proportion of Cost Paid by this Co.	Proportion of Maintenance Paid by this Co.	
						Working	Space	Total					

MICHIGAN RAILROAD APPRAISAL

T.C. Form R.R. 8

______Railroad

Date______

STATEMENT OF CROSSING PROTECTION IN MICHIGAN

______*Office Inspector*

______*Feild Inspector*

	DIVISIONS OF ROAD		Total Numbers Unprotected Grade Crossings	Number Grade Crossings Protected by Alarm Bells What Device is Used	Number Grade Crossings Protected by Gates. What Device is Used	Total Number of Highway Under Crossings	Total Number of Highway Over Crossings	Total Number of Unprotected Electric Railway Crossings	Number of Electric Railway Crossings Protected by Derailer without Signals on Steam R.R.	Number of Electric Railway Crossings Protected by Derailer with Signals on Steam R.R.	What Proportion do You Pay of Installation or Maintenance of Electric Railway Crossings	
	From	To										

MICHIGAN RAILROAD APPRAISAL

T.C. Form R.R. 1

______Railroad

Date______

ENGINE HOUSES AND TURN TABLES

______*Office Inspector*

______*Feild Inspector*

	LOCATION	ENGINE HOUSES						TURN TABLES					
		Kind of Structure	No. Stalls	No. Pits	Pit Dimensions Feet	When Built		Length Feet	KIND OF TABLE	Foundation	CURBING	When Built	

FIG. 2.

T. C. Form R. R. 2

MICHIGAN RAILROAD APPRAISAL

FIELD INSPECTION REPORT

----------------Railroad

Date----------------

Between----------------*and*----------------*Miles*------*Number of Tracks*------------ *Ties, C. to C.*----------------

Highest schedule passenger train------*miles per hour, Freight*------ *miles per hour.*---------------- ------------ *Inspector*

	MILE	GRADE		TIES		RAIL		BALLAST		FENCE		FROGS AND SWITCHES			CROSSINGS		DRAINAGE	ALIGNMENT	REMARKS
		Yardage	Classification	Kind	Condition	Weight	Condition	Kind	Condition	Kind	Condition	Number	Kind	Condition	Number	Condition			

T. C. Form R. R. 7

MICHIGAN RAILROAD APPRAISAL

BRIDGES

------------Railroad

Date------------

------------ *Office Inspector*

------------ *Field Inspector*

Include all wooden, steel or combination trusses, all girders and I beams spans - if solid floor and ballast please so state.

				FOUNDATION					SUPERSTRUCTURE									
	Bridge Number	LOCATION	NAME OF STREAM	Frame or Pile Abutments	Stone or Concrete Abutments	PIERS	Approx. Cu. Ft. Masonry Piers and Abutments	Number of Ft. Bridge Seat to Water	Number of Spans	KIND	Length out to out	Specification for Loading Required	No. Panels	No., Size and Kind of Stringers	Size and Kind of Beams	How Supported	Size of Ties	Date Built

---

T. C. Form R. R. 17

MICHIGAN RAILROAD APPRAISAL

DRAW BRIDGES

----------------Railroad

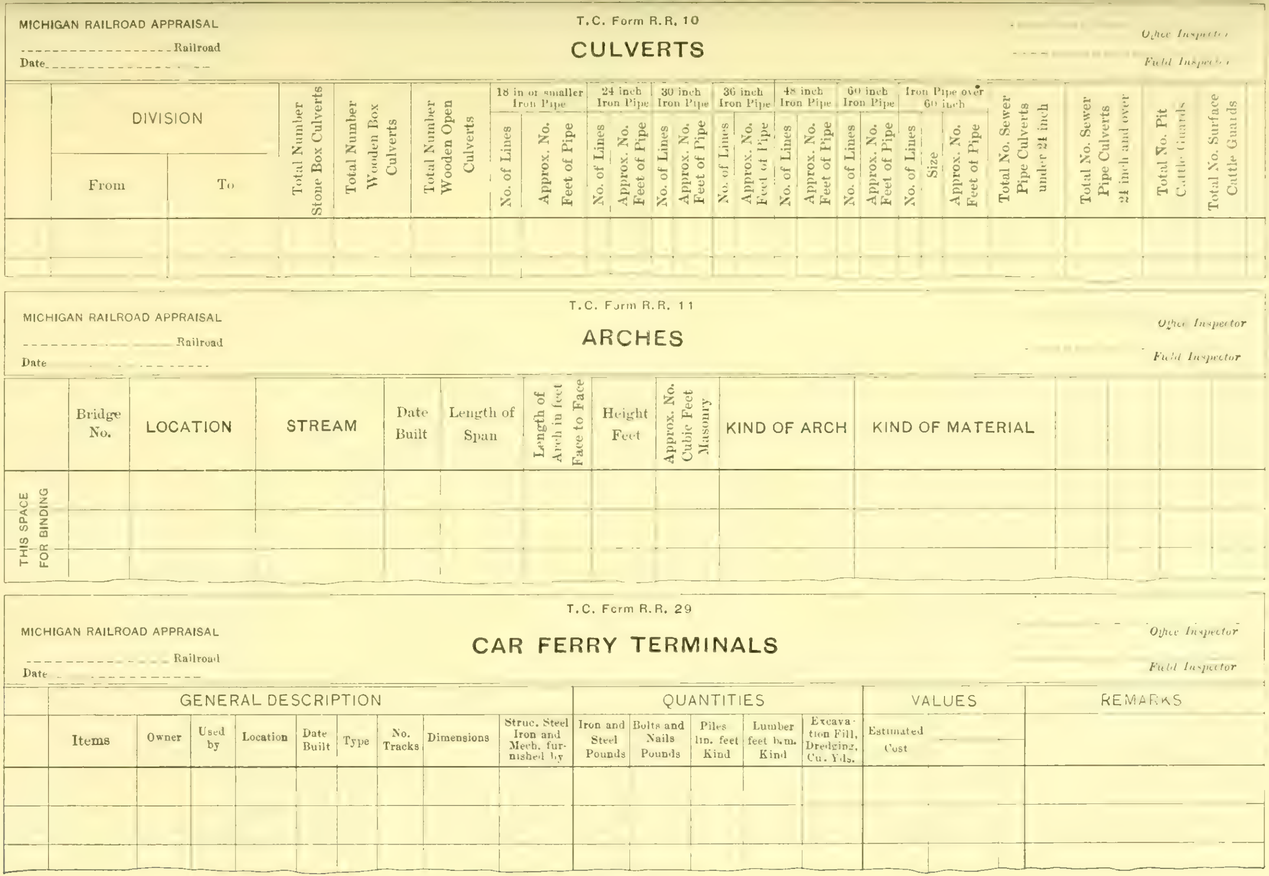
Date----------------

------------ *Office Inspector*

------------ *Field Inspector*

In this table furnish data as to draw span and pivot piers only - other spans in other bridge record.

					FOUNDATION					SUPERSTRUCTURE						
	Bridge No.	LOCATION	Name of Stream	Date of Erection	Material	Size	Approx. Cubic Feet Masonry	Height Above Water	Approx. Depth Footings Below Water	Length Drawn	Kind of Span	Material	SPECIFICATION FOR LOADING	What kind of Power used for swinging	Kind of Turn Tables	



MICHIGAN RAILROAD APPRAISAL
-------------------- Railroad
Date ------------------

T.C. Form R.R. 10

CULVERTS

-------------------- Office Inspector
-------------------- Field Inspector

	DIVISION		Total Number Stone Box Culverts	Total Number Wooden Box Culverts	Total Number Wooden Open Culverts	18 in or smaller Iron Pipe		24 inch Iron Pipe		30 inch Iron Pipe		36 inch Iron Pipe		48 inch Iron Pipe		60 inch Iron Pipe		Iron Pipe over 60 inch			Total No. Sewer Pipe Culverts under 24 inch	Total No. Sewer Pipe Culverts 24 inch and over	Total No. Pit Cattle Guards	Total No. Surface Cattle Guards	
	From	To				No. of Lines	Approx. No. Feet of Pipe	No. of Lines	Approx. No. Feet of Pipe	No. of Lines	Approx. No. Feet of Pipe	No. of Lines	Approx. No. Feet of Pipe	No. of Lines	Approx. No. Feet of Pipe	No. of Lines	Approx. No. Feet of Pipe	No. of Lines	Size	Approx. No. Feet of Pipe					

MICHIGAN RAILROAD APPRAISAL
-------------------- Railroad
Date ------------------

T.C. Form R.R. 11

ARCHES

-------------------- Office Inspector
-------------------- Field Inspector

	Bridge No.	LOCATION	STREAM	Date Built	Length of Span	Length of Arch in feet Face to Face	Height Feet	Approx. No. Cubic Feet Masonry	KIND OF ARCH	KIND OF MATERIAL				
THIS SPACE FOR BINDING														

MICHIGAN RAILROAD APPRAISAL
-------------------- Railroad
Date ------------------

T.C. Form R.R. 29

CAR FERRY TERMINALS

-------------------- Office Inspector
-------------------- Field Inspector

	GENERAL DESCRIPTION									QUANTITIES					VALUES		REMARKS
	Items	Owner	Used by	Location	Date Built	Type	No. Tracks	Dimensions	Struc. Steel Iron and Mech. furnished by	Iron and Steel Pounds	Bolts and Nails Pounds	Piles lin. feet Kind	Lumber feet b.m. Kind	Excavation Fill, Dredging, Cu. Yds.	Estimated Cost		

FIG. 4.

T.C. Form R.R. 20

MICHIGAN RAILROAD APPRAISAL

__________Railroad

Date__________

COAL CHUTES

__________ *Office Inspector*

__________ *Field Inspector*

	LOCATION	Length of Trestle	Kind of Trestle	Foundations	Size of Building	Number of Pockets	Capacity of Pockets	Date Built	Name of Builder	If Hoisting or Conveying Machine in use, State What Kind	

T.C. Form R.R. 19

MICHIGAN RAILROAD APPRAISAL

__________Railroad

Date__________

WATER STATIONS

State whether Power is Steam, Gasoline, Wind Gravity, or Hydraulic Ram

__________ *Office Inspector*

__________ *Field Inspector*

	LOCATION	Source of Water Supply	PUMP			BOILER			PUMP HOUSE				TANK				Length and Size of Suction and Discharge	
			Kind	Size		Kind	Size		Kind	Size		Date Built	Size	Capacity Gallons	Foundations	Date Built		

T.C. Form R.R. 28

MICHIGAN RAILROAD APPRAISAL

__________Railroad

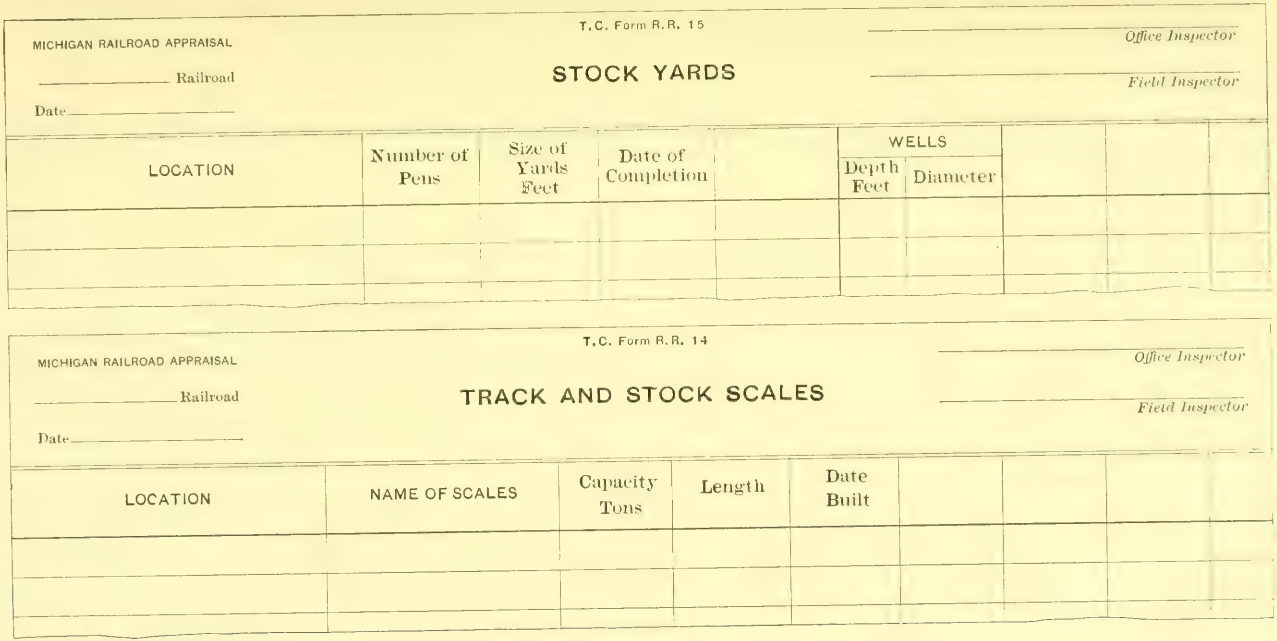
Date__________

ORE DOCKS

__________ *Office Inspector*

__________ *Field Inspector*

	GENERAL DESCRIPTION											QUANTITIES				VALUES			REMARKS
	ITEM	Owned and Used by	Location	Date Built	Type	DIMENSIONS						Rods, Bolts, Iron, Pounds	Piles Lin. Feet Kind	Lumber Feet B.M. Kind	Fill and Dredging	Estimated Cost			
						No. Pkts.	Cap. Tons	Hgt. Water to C.L. Hge.	Hgt. Water to Deck	Width	L'gth of Chutes								



MICHIGAN RAILROAD APPRAISAL
T.C. Form R.R. 15
__________ *Office Inspector*
__________ Railroad
STOCK YARDS
__________ *Field Inspector*
Date__________

LOCATION	Number of Pens	Size of Yards Feet	Date of Completion		WELLS				
					Depth Feet	Diameter			

MICHIGAN RAILROAD APPRAISAL
T.C. Form R.R. 14
__________ *Office Inspector*
__________ Railroad
TRACK AND STOCK SCALES
__________ *Field Inspector*
Date__________

LOCATION	NAME OF SCALES	Capacity Tons	Length	Date Built			

Fig. 6.

T.C. Form R.R. 13

MICHIGAN RAILROAD APPRAISAL

STATEMENT OF MISCELLANEOUS BUILDINGS

_______________ Railroad

Date _______________

_______________ *Office Inspector*

_______________ *Field Inspector*

Include in this report all shops, warehouses, car houses, watchmen's shanties, flagmen's buildings, elevators, general office buildings and all other structures not specifically asked for in other reports.

LOCATION	DESCRIPTION OF BUILDING	SIZE	Kind of Bldg., Brick, Stone or Frame	Date of Completion		

T.C. Form R.R. 12

MICHIGAN RAILROAD APPRAISAL

STATION BUILDINGS

_______________ Railroad

Date _______________

_______________ *Office Inspector*

_______________ *Field Inspector*

LOCATION STATIONS	DESCRIPTION OF BUILDING	SIZE	Kind of Bldg., Brick, Stone or Frame	Date of Completion		

THIS SPACE FOR BINDING

MICHIGAN RAILROAD APPRAISAL

T.C. Form R.R. 22

____________________Railroad

REAL ESTATE

NOT USED FOR RAILROAD PURPOSES

Date____________________

____________________*Office Inspector*

____________________*Field Inspector*

LOCATION		DESCRIPTION	Assessed Value	TOTAL TAXES	
COUNTY	ASSESSMENT DISTRICT			AMOUNT	AMOUNT PAID

THIS SPACE FOR BINDING

MICHIGAN RAILROAD APPRAISAL

T.C. Form R.R. 23

____________________Railroad

MISCELLANEOUS EQUIPMENT

ROLLING STOCK

Date____________________

____________________*Office Inspector*

____________________*Field Inspector*

Location	No.	Name	Description	Capacity	Date Built	Cost When New	Remarks

Fig. 8.

THIS SPACE FOR BINDING

T.C. Form R.R. 24

MICHIGAN RAILROAD APPRAISAL

_______________Railroad

Date_______________

SHOP MACHINERY AND TOOLS

_______________ *Office Inspector*

_______________ *Field Inspector*

Description	Maker	Date Built	Size	Cost When New	Remarks

T.C. Form R.R. 25

MICHIGAN RAILROAD APPRAISAL

_______________Railroad

Date_______________

STEAM SHOVELS, DREDGES, PILE DRIVERS

_______________ *Office Inspector*

_______________ *Field Inspector*

	MAKE OF SHOVEL	PROPERTY OF	Year Built	Size of Dipper Cu. Yds.	Shop Number	Cost When New	Present Value Pct New	REMARKS

T.C. Form R.R. 26

MICHIGAN RAILROAD APPRAISAL

_______________Railroad

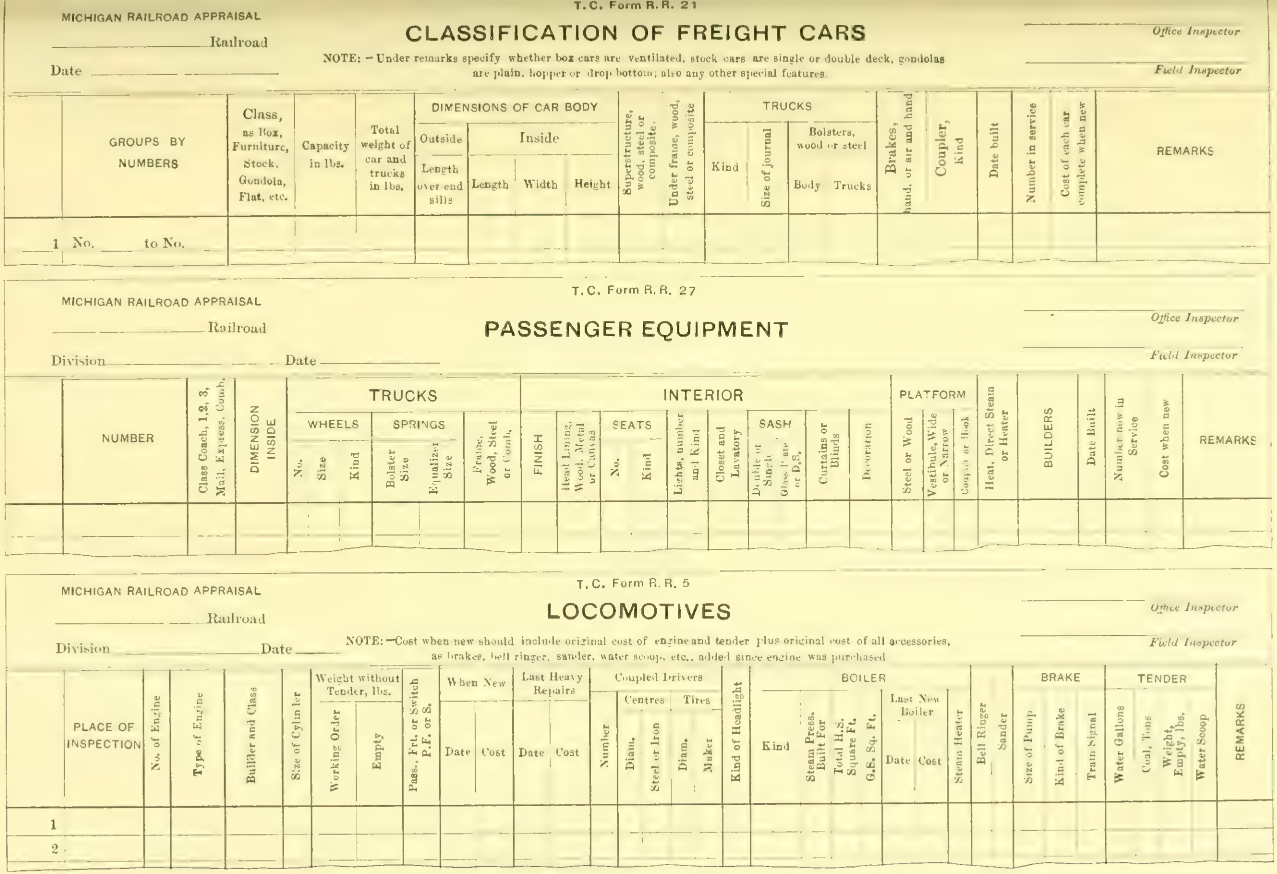
Date_______________

DOCKS AND WHARVES

_______________ *Office Inspector*

_______________ *Field Inspector*

GENERAL DESCRIPTION								QUANTITIES				VALUES			REMARKS
	ITEMS	Owner	Used by	Location	Date Built	Type	Dimensions	Rods, Bolts Nails etc. Pounds	Piles Lin. Feet Kind	Lumber Feet B M. Kind	Excavation Fill Dredging, Cu Yds.	Estimated Cost			



T.C. Form R.R. 21

MICHIGAN RAILROAD APPRAISAL

________ Railroad

Date ________ ________

CLASSIFICATION OF FREIGHT CARS

NOTE: – Under remarks specify whether box cars are ventilated, stock cars are single or double deck, gondolas are plain, hopper or drop bottom; also any other special features.

________ Office Inspector

________ Field Inspector

	GROUPS BY NUMBERS	Class, as Box, Furniture, Stock, Gondola, Flat, etc.	Capacity in lbs.	Total weight of car and trucks in lbs.	DIMENSIONS OF CAR BODY				Superstructure, wood, steel or composite.	Under frame, wood, steel or composite	TRUCKS				Brakes, hand, or air and hand	Coupler, Kind	Date built	Number in service	Cost of each car complete when new	REMARKS
					Outside	Inside					Kind	Size of journal	Bolsters, wood or steel							
					Length over end sills	Length	Width	Height					Body	Trucks						
1	No. ____ to No.																			

T.C. Form R.R. 27

MICHIGAN RAILROAD APPRAISAL

________ Railroad

Division ________ Date ________

PASSENGER EQUIPMENT

________ Office Inspector

________ Field Inspector

	NUMBER	Class Coach, 1,2, 3, Mail, Express, Comb.	DIMENSION INSIDE	TRUCKS						INTERIOR										PLATFORM			Heat, Direct Steam or Heater	BUILDERS	Date Built	Number now in Service	Cost when new	REMARKS
				WHEELS			SPRINGS		Frame, Wood, Steel or Comb.	FINISH	Head Lining, Wood, Metal or Canvas	SEATS		Lights, number and Kind	Closet and Lavatory	SASH		Curtains or Blinds	Decoration	Steel or Wood	Vestibule, Wide or Narrow	Coupler or Hook						
				No.	Size	Kind	Bolster Size	Equalizer Size				No.	Kind			Double or Single	Glass Plate or D.S.											

T.C. Form R.R. 5

MICHIGAN RAILROAD APPRAISAL

________ Railroad

Division ________ Date ________

LOCOMOTIVES

NOTE: —Cost when new should include original cost of engine and tender plus original cost of all accessories, as brakes, bell ringer, sander, water scoop, etc., added since engine was purchased

________ Office Inspector

________ Field Inspector

	PLACE OF INSPECTION	No. of Engine	Type of Engine	Builder and Class	Size of Cylinder	Weight without Tender, lbs.		Pass., Frt. or Switch P.F. or S.	When New		Last Heavy Repairs		Coupled Drivers					Kind of Headlight	BOILER						Steam Heater	Bell Ringer	Sander	BRAKE			TENDER				REMARKS
						Working Order	Empty		Date	Cost	Date	Cost	Number	Centres		Tires			Kind	Steam Press. Built For	Total H.S. Square Ft.	G.S. Sq. Ft.	Last New Boiler					Size of Pump	Kind of Brake	Train Signal	Water Gallons	Coal, Tons	Weight, Empty, lbs.	Water Scoop	
														Diam.	Steel or Iron	Diam.	Maker						Date	Cost											
1																																			
2																																			

FIG. 10.

That a few changes were made in 1904 was to have been expected; that these forms were almost in their entirety made a basis for the similar work of the Wisconsin appraiser, some three years later, was in the nature of a high compliment and goes far toward answering the criticisms of this part of the work, generally to the effect that the forms call for much more information than could possibly be used, and that they show lack of care in arrangement.

It may be said here, properly, that the uncertainty as to the final attitude of the companies made it essential that the appraiser prepare, if need be, to make his inventory by personal inspection in the field. Indeed, this was done in the case of several roads, and, while most of the companies finally accorded every courtesy, either giving the appraiser access to their records, or furnishing the information desired, it is not probable that the shortness of the time limit would have enabled the appraiser to secure any sort of result had a modified plan been adopted.

The law provided no requirement that the companies should furnish any information. In order to secure the data, it would have been necessary to employ a large number of men, and this would have been such a serious expense to the companies that refusal to comply would probably have followed such a request. Many of the companies had no men in their service able to prepare the required data; and, finally, eight or ten men after having worked in the files of companies owning reasonably full records, were much better able to take off the desired data intelligently from the records of other companies than men unfamiliar with the needs of the appraiser and with no prior experience. Then, too, the work secured was that of one body of technical men, all experienced in different phases of railway work, and thus was uniform and consistent. Had seventy-five or eighty different men or sets of men prepared these inventories, there would certainly have been a great variation in their worth and reliability.

It must be kept clearly in mind that lack of time was the main feature which kept the appraiser from considering any such plan of co-operation with the railroads as was adopted later in Wisconsin and Minnesota, and that no distrust of the railroads, or lack of desire to co-operate, had anything to do with the appraiser's decision to use the method which was adopted.

Shortly after the preparation of the blanks, access was granted to the records of the Ann Arbor Railroad, and almost immediately thereafter several other companies opened their files to the appraiser; the State Board of Auditors determined to pay the bills, as approved by the appraiser; and the initial difficulties were so far removed that it was possible to carry out, without any further delays, the plan of organization which had been perfected.

The personnel of the staff was considered to be of the greatest importance, and, in the selection of men, the requirements desired were: experience in the construction and operation of railroads, thorough technical training, high standing in the Profession, as shown by membership in the American Societies of Civil or Mechanical Engineers, or of other Societies of high standing, and high moral character. Politics, residence in the State, or local influence, had absolutely no weight in the selection of any of the men. In a number of cases men were secured who had for some years occupied the position of Chief Engineer of important lines. In a very large number of cases men who were engaged on this work have since its completion held the position of Chief or Principal Assistant Engineer of important railroads, and practically all of them returned to railway service. Dozens of these men are well known, and their work deserves that full credit should be given to each, but it is impossible to do so within the limits of this paper.

The minor positions, such as assistants in the field and in the computing and compiling rooms, were assigned to younger men, generally with some railroad experience, and in many cases they were graduates of technical schools, Cornell, Yale, Rensselaer, Michigan, Ohio State, and other schools having representatives.

The writer believes that no more harmonious or loyal organization was ever gathered together before, or has been since. Men who had held Chief Engineerships trudged miles in the wilds of Michigan on foot, inspecting and inventorying property, and came into the office and worked long hours at the computing tables with the utmost cheerfulness and *camaraderie.* There was complete harmony, absolute loyalty, and as perfect a spirit of unselfish devotion to the work as the writer has ever seen in any organization.

The fact that such a staff of engineers, of wide experience in railroad construction and maintenance, had been assembled, made it feasible to carry out a plan of the appraiser which proved to be of great value. At frequent intervals, during the progress of the work, conferences were held which were attended by all the heads of departments and by many of the older and more experienced engineers. Matters of policy, details, general principles, and rules and methods for conducting the appraisal, were fully discussed, and stenographic records were made of the discussion and conclusions. These conferences covered practically every question that arose; they were of such a nature as to draw out the opinions of the men fully and freely; and their effect was to eliminate the error due to individual judgment, and harmonize and unify the methods and results of the appraisal.

Special emphasis has been laid on the organization of the staff, because the criticism has been made that this work was lacking in care, was hurriedly done, and was unreliable. The work must be judged by its results, but the criticism that it did not receive proper care is absolutely unjustified in fact. The men engaged were of the highest type of experienced, technically educated, and highly qualified engineers; they entered the work unreservedly, and gave the best there was in them. The Michigan appraisal was not a one-man job; it was the work of many men, and all are entitled to credit.

That some men in an organization such as this, gathered from all over the United States, should prove to be lacking, and should fail to hold their place with their fellows, was to have been expected. That the number of such men should not exceed half a dozen was remarkable. In fact, almost every such case was found when the first notes were returned to the office, and in only two or three instances was it necessary to send a second man to do work which had been once covered. In several cases men were sent over certain sections which had been inspected by some one else, with a view of getting an idea of the personal judgment of the different men, but in such cases the results were astonishingly close, and created the greatest confidence in the figures of depreciation which were being received.

Looking back on this work, after the lapse of 10 years, after having fully reviewed it twice, and examined all records, after having heard the men engaged on it testify in court, and knowing the record of these men since the completion of the work, the writer believes himself fully justified in stating that, no matter what opinion may be held as to the accuracy, reliability, or value of the result, no charge of carelessness, neglect, undue haste, or lack of consideration can be sustained as against the staff.

To strengthen the work further, to eliminate the element of personal error, to guard against the danger of dulled perceptions due to constant application to the work, and to forestall, if possible, every point of objection to methods, a Board of Review was chosen by Appraiser Cooley to whom were referred:

(*a*) The methods of inventory and valuation, as determined by the staff;

(*b*) All points on which special discussion or difference of opinion were noted in the working conferences;

(*c*) Questions as to elements of value in the physical property which were in themselves not tangible or capable of inventory; and finally,

(*d*) The results of the whole work.

The members of this board were chosen on account of pre-eminent standing in the Profession, and on account of experience and prominence in railway engineering. The board was composed of four men, as follows:

Chairman, Octave Chanute, Past-President, Am. Soc. C. E., former Consulting Engineer, Atchison, Topeka and Santa Fe Railway, but at the time not engaged in active railway work.

George W. Vaughn, M. Am. Soc. C. E., Engineer in charge of Track Elevation in Chicago.

Charles E. Greene, M. Am. Soc. C. E., Dean of the School of Engineering, University of Michigan.

Charles Hansel, M. Am. Soc. C. E., former Engineer, Wabash Railroad, former Chief Engineer, Illinois Railway and Warehouse Commission, and at that time General Manager of the National Switch and Signal Company.

These gentlemen were not engaged in any detailed work on the appraisal; they came to the work for one week each month with minds entirely clear of all confusion raised by issues of detail, and were thus enabled to pass as a court upon all matters laid before them. Their association was of inestimable value in giving confidence to the members of the staff. The many years of railway service of Messrs. Chanute and Vaughn, and their unquestioned ability in that special field of engineering, gave the stamp of finality to points decided by them. The special knowledge of Mr. Hansel in the field of signal engineering, and his known ability as an expert in organization and administration, were of the greatest value. The service of Professor Greene was that of the analyst and logician; his clear and judicial mind enabled him to formulate the final arguments in many cases under consideration.

The writer wishes to make it perfectly clear that he has not attempted to minimize the work of Professor Cooley by stating the exact relation of the many engineers on the staff to this work, but to bring out and emphasize the fact that no one man, or no two or three men, were responsible for any single part, but that the whole represents the best efforts of sixty or seventy experienced men working to secure a fair, honest, unprejudiced, engineering estimate along such lines as would eliminate, as far as possible, all errors of individual judgment.

It has never been claimed for the work that it was perfect, or that it was entirely free from errors. It has been and is claimed for it that it probably represents as close and conservative an estimate of cost of reproduction and depreciation as it would be possible for any set of men to make under the conditions then existing.

Professor Cooley was in constant touch with the work, knew its every detail, passed upon and approved every rule and order, presided at every conference, and nothing more than his activity, optimism, and constant watchful care and tireless energy kept the force at work day and night and brought about the prompt completion of the details. His recognized high standing, his remarkable ability as an executive and organizer, and his powers of diplomacy, more than anything else, brought about the final acquiesence of the railroad managers and kept up the confidence of the State authorities; his personality pervades the entire work. After giving all due credit to the staff, and they were entitled to much credit, the real honor must go to Professor Cooley. It was his conception, his plan, and the brunt of the battle was his.

Office and Field Methods.

The preliminaries of the organization having been completed, and the forms prepared, a portion of the working force was brought on the ground, and the work was actively commenced. It was subdivided into four parts:

(*1*) Office inspection, or inventory;
(*2*) Field inspection;
(*3*) Computation;
(*4*) Compilation for the permanent record.

The men chosen as field inspectors were old and experienced railroad engineers. As far as possible, they were assigned for a short period to office inspection, then they were sent into the field, after which they worked at the computation of values; so that each man was engaged on many different phases of the work, and handled the notes of many of his fellows, and no one man made up one complete appraisal, except as specially noted.

Making the Inventories.—Office inspection, or the preparation of inventories, was assigned to parties usually of one or two experienced men with from two to four younger engineers as assistants in the computing-room. These men went to the general offices of the railroad companies and made a complete examination of maps, profiles, bridge and building records, records of motive power, rolling stock, etc. In short, they prepared, as far as it was possible to do so, a complete inventory of every building, structure, or piece of property owned by the road; they took off complete abstracts of real estate and right-of-way records; they noted principal yards and terminals, and secured maps of such as were most complex, or furnished lists of such maps and records as were most essential for the field men, and they made as complete a report as possible of the corporate history of the road and the general condition of its engineering records. No effort whatever was made to examine or audit the financial books of any company, or to secure from such books any data as to cost of property; the work was entirely limited to the listing of physical property.

Most of the railroad companies co-operated, and gave access to their records; one or two filled in the forms; a number had practically no records, and only one or two companies withheld information. Requests for blue prints of large yards and terminals, and of plans of standard structures were generally granted cheerfully, and, although there was no such spirit of co-operation as was shown later by the Wisconsin roads, much labor was saved by the data furnished.

The result of the office inspection was the filing of inventories, which were generally quite complete, the securing of maps and plans, the gathering of data as to prevailing prices of labor and material, and the securing of some very valuable cost data as to special structures and classes of structures. All inventories were made up for roads, or for divisions of roads, with each class of property listed separately, for example, station buildings, interlocking plants, bridges, etc., so that, if necessary, any special class of inspection might be assigned to one man, while to others could be assigned the remainder of the work on that particular road or division.

Office Inspection as a Check on Field Work.—The office inspection furnished many valuable data for checking the judgment of the field men. For example, the number of cubic yards of excavation and embankment on probably the greater part of the mileage had to be secured by the field inspectors, either because the records had not been kept or the changes of line and grade had been so extensive as to destroy their reliability. Every field inspector, therefore, made his own estimate of the yardage of pay earth. The office inspection reports, however, gave reliable data (from profiles or original contract estimate files) of the actual yardage on possibly 2 000 or 3 000 miles of line, so widely scattered that it constituted a check on the work of a majority of the field men.

This work of office inspection disclosed the following points, which will be practically common to all large valuation jobs:

(*a*) There was no uniformity of method in the keeping of records of permanent way and structures;

(*b*) There was a vast amount of carelessness in keeping records up to date, even on the larger roads;

(*c*) The smaller roads, not only had little or nothing in the way of records, but had in many cases no department with employees qualified to make or keep such records;

(*d*) The purchase of new equipment, the construction of new buildings and bridges, and the destruction, sale, or removal of old property, create a condition of continuous change which is seldom recorded by either operating or accounting officials, and makes book inventories derived from the roads of very doubtful value for use in an appraisal.

Field Inspection.—The decision had been reached, after careful discussion, not to permit the field inspectors to place a money value on any structure, but to examine it, make a full description of it in all particulars, and assign to it a percentage which should represent the present value, or the depreciation from a similar new structure rated at 100 per cent.

The field inspectors were furnished with the records of the office inspection covering the district assigned. They were given notebooks, tape lines, and various blanks for reporting progress and recording original estimates in the field. Provision was made for inspection by the field men, either by the use of hand-cars, gasoline inspection cars, or velocipede cars, although, with one or two of the roads, no satisfactory arrangement could be made, and the men were compelled to go on foot. A careful inspection of every structure was made. If any correction to the office inspection record was necessary, it was made; if the structure was new, it was carefully measured and described, and everything noted which would be of service in estimating its value. Side-tracks were measured, and the weight and type of rail noted. All culverts and bridges were examined, described, and their condition noted. Estimates were made of excavation and embankment, clearing and grubbing, etc. (based on the standing timber at the time of the examination), and careful estimates were made of classifications of material. The records of the field inspector generally contained only the description and the percentage, but, occasionally, when apparently valuable information as to cost of any particular structure was available it was noted, as was special information of local matters affecting the value of any part of the work.

It was the plan (carried out with but few exceptions) to complete the record with the field inspector so that from his notes a full and accurate descriptive inventory might be made. There were a few exceptions to the general method of field inspection work as outlined, which were:

Special Work on the Chicago and Northwestern Railway.—The Chicago and Northwestern Railway had no records of any sort, all construction papers having been destroyed by fire. This company organized and placed in the field four complete engineering parties, each under one of their own engineers, and with each party was sent one field inspector. The line was carefully surveyed and cross-sectioned, and complete records of every building and structure were made, side-tracks were measured, and data taken for rail and ballast charts, etc. All work was done in the presence of the field inspector, and he was given copies of all notes. He placed his own percentage of depreciation on everything. The estimates, made up independently by the Chicago and Northwestern engineers and the appraisal staff, using in the latter case the same unit prices as applied elsewhere in the Upper Peninsula, varied less than 2 per cent.

Special Valuations.--Certain special structures, such as ore docks and ore and coal handling machinery, were of such a character as to require expert appraisal. These were examined in the field, appraised, and valued by G. H. Hutchinson, M. Am. Soc. C. E., whose special training and experience in such work had qualified him perhaps better than any other man. Interlocking and signaling plants were specially appraised by the late Elliot F. Moore, who for 10 years had been Engineer of the Michigan Railroad Commission, and whose intimate personal knowledge of almost every plant in the State specially qualified him for this work.

Some of the bridges were of such a character as to require expert knowledge, and this inspection was assigned to William Dunbar Jenkins, M. Am. Soc. C. E., a man of ripe experience and sound judgment. The larger and more elaborate station buildings were examined and appraised, and values finally placed by Mr. F. G. Susemihl, Chief Architect of the Michigan Central System, whose special work in railway buildings made him thoroughly familiar with these values.

Work equipment and special equipment were appraised by Mr. G. L. Lewis, who had been connected with the Marion Steam Shovel Company for many years.

Except for these special assignments, all the field inspection was handled in accordance with the appraiser's plan.

As stated previously, in only two or three cases was it necessary to re-inspect, and, while several sections were intentionally gone over a second time, without letting the field inspector know who had done the work previously, or what his percentages had been, the result of all these checks was to justify the figures in the earlier inspection and to strengthen confidence in the work.

The field inspection of the Mechanical Department involved examining and placing a percentage value on each locomotive, passenger car, and piece of special equipment, and on all shop machinery. Inasmuch as several points of special interest are involved in this inspection, it will be discussed at more length in the section of the paper relating to the methods of work of the Machanical Department.

Computation.—After the completion of the field inspection, all notes were placed in the hands of the computing force. This organization consisted of two classes of men, engineers brought in from field inspection, and younger engineers. All computations were made independently by two men, and all work was checked carefully.

Every man in the computing room was furnished a large bound blankbook, in which he was required to make all his notes and computations, no figures of any sort being made on loose paper. The name of each man was placed on his notebook, and each set of field and office inspection notes worked upon by him was signed with his initials. It was easy to trace the work of every man, and in the subsequent trial of the Tax Cases, every man in the service returned, and, not only testified as to his office and field inspection, but was able to turn to and identify all the computations made by him and produce his original figures and memoranda.

Very soon it became evident that such a volume of reports, notebooks, memoranda, maps, plans, pamphlets, and other data was being accumulated that, unless a special system was developed for filing and handling in the office, the confusion would be serious and costly.

Filing in Office.—The system of filing and record keeping had the merit of being simple and inexpensive. There was borne in mind, in devising this plan, the necessity of keeping all papers connected with one division of any road together, the need for reducing to a minimum the labor of filing and indexing, the constant use of papers, and their frequent withdrawal from the files, making it necessary that they could be at once located when they were not in the files.

The vault in the appraisers' office was arranged so that large manilla envelopes, each of sufficient size to hold all the reports, notes, maps, etc., of each road or division, could be filed vertically. Each road was given a number; if there were several divisions, each division was given a letter, as "15-*A*," "15-*B*," etc., and each division was filed separately.

Every report, book, map, or other paper was stamped with its road or division number and letter, and given a sheet number. In this manner every paper was identified, and could be at once placed. A record was kept in a book, describing every paper filed in each envelope.

In issuing papers for work, the entire file was taken and kept together at all times.

One man had charge of the filing and recording, and no one else was permitted to enter the vault. When a file was withdrawn, a receipt was taken, and was put in the place of this file; and when the papers were restored to the vault the receipt was destroyed.

The system proved adequate, and was much less cumbersome than a more elaborate system of card indexing of separate papers could possibly have been.

The net result of office and field inspection had been an inventory based on the railroad records, checked by a man in the field, with a percentage representing the field inspector's judgment as to depreciation, together with a considerable number of special data as to original cost, etc. It was now necessary to place figures of estimated cost of reproduction and depreciation in terms of money.

The State of Michigan is made up of two peninsulas, widely separated, with radically different conditions prevailing as to certain items of the cost of construction.

Computation Tables.—This appraisal involved seventy-eight incorporated and forty-seven unincorporated railroads. It was necessary to adopt such a system as would apply uniform methods and prices to all like property. Accordingly, the field inspectors were assembled, and, after conference, it was determined to prepare a set of tables, covering all classes of railway construction, material, and structures, values being computed for 100% value, and for each 10% depreciation. These tables covered different weights, sizes, and types of structures and material, and were all computed on the basis of the agreed estimated cost.

Unit Prices.—The unit prices were the result of a most careful study and discussion. For many items, such as clearing, grubbing, earthwork, masonry, etc., the price was fixed by agreement during the discussion at a figure which represented the fair average cost of this particular item during the 5-year period preceding the appraisal.

For rails and rail structures, an average price was secured from market quotations for a period of 10 years, a price was determined as the value of scrap, and the percentage of depreciation was applied to the wearing value of the rail. The unit price was $28; the agreed scrap value was $12, leaving $16 as the wearing value of the rail. If an inspector reported rail at 90%, or at 30%, this percentage was taken from the $16 wearing value and to this was added the scrap value. The tables were arranged so that, for any weight of rail and any percentage, the cost of reproduction and the present value could be taken from the tables in dollars per mile. The same was true of bolts, spikes, angle-bars, fish-plates, and frogs and switches.

In the case of material such as ties, where no scrap value could be attached, the percentage was applied directly to the first cost.

In the case of bridges, the tables gave weights per foot and per span for various lengths, types of structures, and loadings, and only the cost of reproduction was estimated.

Estimated costs per cubic foot were deduced for buildings of various standard railroad types and per square foot for depot platforms. These figures were obtained by reducing to this basis the cost of a large number of buildings of known cost, by comparison with data obtained from railroad companies and from a number of engineers who had kept such records, and by consultation with architects. These building tables did not apply to the more elaborate and costly structures, all of which were appraised specially.

Ballasting, track laying, and surfacing were divided into three and four classes, in order to cover the different general types of railroads, and prices per mile were fixed. On Upper Peninsula roads ballasting was estimated at a higher price than on Lower Peninsula roads, while ties and timber construction were estimated at a lower figure.

In addition to these prices, secured by averaging several years' quotations, or by agreement of experienced construction engineers, many valuable figures were obtained from manufacturers of locomotives, cars, mechanical equipment, and bridges; and in several cases access was given to the mechanical cost data of the larger roads. Specifications for locomotives, cars, and shop tools were sent out to builders with a request that they give average prices for a period of years.

From all this mass of data the unit prices for the valuation were determined. For locomotives, values were plotted for engines of different weights, in order to establish a curve, and curves representing deterioration, scrap value, and major repairs were also plotted, so as to ascertain diagrammatically the value of an engine of given weight and stated condition.

The tables and diagrams proved of incalculable benefit in reducing the work, and in securing that absolute uniformity of method necessary to give the appraisal standing.

It may not be amiss to state here that in such a work no set of unit prices could possibly be adopted which would not work some apparent injustice. A number of Michigan lumber roads were of the cheapest possible type of construction, and any unit price applied to ties or timber, which would be at all reasonable for such roads as the Michigan Central, Grand Rapids and Indiana, Pere Marquette, and others, would be far in excess of the actual money paid out by these little roads. A few individual instances of such apparent discrepancy were cause of complaint and criticism, but, on analysis, very generally, these did not appear to be anything but a disagreement with book values, in which ties cut off the right of way were treated as having no cost; or in some similar item certain local conditions may have made the first cost so low as to amount to a donation of property. Conceding the propriety of the objections, the reason for making the appraisal was to furnish information on which the legislature might determine whether the State should go from a specific to an ad valorem basis, and in view of this purpose the objections became unimportant, as they applied to but a few miles of road.

Classification.—All work of computation was classified in strict accordance with the Interstate Commerce Commission's classification of construction accounts, to which were added one or two classifications not recognized by that Commission, and final summaries were returned on sheets similar to those illustrated by Figs. 1 to 10.

In computing, the staff made use of all data of every nature which was before them, checked the judgment of the field inspector wherever any reliable data were furnished, took into account age, special notes, or costs, and, in case of any serious discrepancy in his percentage, reported to the head of the department for either a re-inspection or for a conference with the appraiser and inspector. In this department every possible safeguard was thrown around the work to insure its absolute mathematical correctness, and to guard against errors in the personal equation.

Compilation.—After the calculations were checked and completed they passed to the compilers, who arranged and classified them, and prepared the form of the final report. This consisted of a detailed list of every piece of property and every structure, with a short description and specification, and a statement of estimated cost of reproduction and present value. The division is made by roads, by divisions of roads, and by counties. This was done after the completion of all other work, and the disbanding of the organization, a small force being retained by the State to compile and put in permanent form all the papers of the appraisal. This work was done under the direction of Messrs. James Walker and O. C. Le Suer in consultation with Professor Cooley.

The final compilations were typewritten on large sheets and bound, and constitute the final record of the physical valuation. After the completion of the 1900 appraisal, all papers connected with the work of the computing office were arranged in proper order and bound.

Special Problems of the Mechanical Department.

The Civil Engineering section dealt wholly with fixed property located entirely within the State; and the work offered no special difficulties in the way of assignment of values. It is true that, when the question of terminal values was under discussion, the Wisconsin and Michigan Railroad offered a very pretty example, in that the revenue-producing half of its mileage lay in Michigan, while its shops, yards, docks, and car ferries, comprising the great bulk of its physical property, were in Wisconsin. This instance merely emphasized the fact that no State valuation of an interstate property can settle finally and definitely all the questions that arise.

Assignment of Value to States.—The Mechanical Department was compelled to handle the valuation of moving property, and to assign values as between the States on such a basis as would be fair to all parties. The Courts have been inclined to view the distribution of values between territorial units on the track-mileage basis as being a fair one. The study of the problem in Michigan indicates that while this method, perhaps, is just in most cases, it will not hold in all. Assignment was made upon several bases, as follows:

(*a*) Main-line mileage;
(*b*) Total track-mileage;
(*c*) Car- and locomotive-mileage of equipment operating in Michigan;
(*d*) Car- and locomotive-mileage, entire equipment;
(*e*) Freight-car mileage of the entire system.

The results secured by these different methods show, in many cases, very little difference; all are close, and no injustice is worked by any method, while, in other cases, the figures are widely divergent.

The Lake Shore and Michigan Southern Railway owns a high-class main line between Chicago and Buffalo, and for part of the way there are two lines several miles apart; the entire line is double-tracked, and there is much third track. None of this line is located in Michigan, except some 80 miles of single-track main line of the Michigan Division between Toledo and Elkhart. The company, however, has several hundred miles of branch line in Michigan, which comprises most of the branch-line mileage of its system. These lines, generally, are far inferior to its main line.

Any apportionment of its equipment between States on the basis of either line mileage, total track-mileage, or locomotive- and equipment-mileage of total equipment will result in the assignment to Michigan of a value far in excess of a proper or fair amount. An apportionment of locomotive and passenger-car equipment on the basis of equipment mileage or equipment operating in the State, and for freight cars on the basis of car-mileage of total equipment, was found to be most fair.

In making the assignment of values, this study was made for all interstate roads, and such basis used as was apparently most fair in each case, the department making a special effort not to assign to Michigan undue values or those which could not be sustained.

Freight Car Inspection.—One of the most perplexing problems which was faced by the Mechanical Department was the proper and satisfactory inspection and valuation of freight equipment. The freight cars owned by the companies were scattered over the United States and Canada, and the inspection of any considerable percentage of those owned by any company was, of course, an impossibility.

The fact that these cars had been purchased in series, so that there were considerable numbers in a group, all of the same age, and built according to the same specifications, made possible a valuation by groups. The acceptance, however, of any arbitrary percentage of depreciation by years, or the acceptance of the rules of depreciation of the Master Car Builders Association, without making independent investigation with a view of establishing the correctness of the rule, appeared to be unwise.

The several companies submitted carefully prepared statements of equipment. These statements were compared with the equipment register and the reports to the Commissioner of Railroads. The prices used were those of the rules of interchange of the Master Car Builders Association wherever applicable.

Prices were furnished by the leading manufacturers, and in many cases were secured from the books of the railroad company.

In order to determine the condition of the equipment, the inspectors of the department personally examined 32 000 freight cars in Michigan and adjoining States. Their reports were separated, classified, and analyzed by groups, with the result that the inspection fully confirmed and justified the use of the rule for depreciation of the Master Car Builders Association, which was therefore applied. In the 1902 appraisal this rule was accepted without any inspection or further study of the problem.

The criticism of this part of the work by the appraiser of the State of Washington is wholly unjustified, as the work was necessary in order to qualify in Court and defend the rule adopted, and the actual cost of the work was small.

Locomotives.—The inventory of locomotive equipment was secured from the companies, and checked against reports and the equipment register. Personal inspection was made of every locomotive in the State, then a complete description was prepared, and the percentage of depreciation assigned. Curves of depreciation had been computed and plotted, and the figures of the inspectors were compared carefully with the curve in order to eliminate possible errors.

Vessels.—Professor Sadler's appraisal of vessels involved a personal examination of every vessel. This survey included:

(*a*) The hull of the vessel and general equipment;

(*b*) The machinery and boilers.

An independent estimate of the cost of reproduction and depreciation was made, and, wherever possible, this was checked by comparison with the detailed original cost. In case of material difference, various shipbuilders were consulted, and independent estimates of cost were secured. In every case these latter estimates were confirmatory of the estimated cost of reproduction, which figures were used throughout the appraisal.

Overhead Charges.

There are certain expenses connected inseparably with the construction of any public work, which, on the completion of that work, are not capable of physical identification, but which, nevertheless, belong to and must be a part of the cost of the physical property. These expenses are legitimate; and, as long as the property is operated, a very large part, if not all, of the entire expense remains in the present value of the property as a "going concern."

Appraiser Cooley and his staff took up the discussion of these items and disposed of those which were carried into the valuation by the placing of a percentage. These items are:

Engineering.—This covered all the cost of preliminary and location surveys, design, and supervision of construction of the work, and all expenses connected therewith. This was covered by a charge of 4% of the cost of reproducing the permanent way and structure, but not the equipment.

Legal Expense.—This item is inseparable from the construction work, and was fixed at one-half of 1% of the cost of the same items as affected by the engineering charge.

Organization Expense.—This covered the cost of promotion, financing, and general supervision of construction, together with general office expense. These items were covered by an application of 1½% of the cost of the above items.

Interest.—This item is intended to cover interest on money during the period of construction. The length of time taken to build would, of course, be variable. It was assumed that 3% on the entire cost of construction and equipment would be conservative, and this figure was used.

Discount on Bonds.—This was not included, for the reason that it was considered, not as a proper capital charge, but rather as an adjustment of the interest rate to the existing market condition, and as chargeable to interest account and not capital.

The discussion among members of the staff indicated such a wide range of opinion as to the proper percentages to apply, that the final determination of the rates was passed upon by the Board of Review. There can be no question as to the propriety of these items as proper elements in the first cost of construction of a new railroad. On the theory that the cost of reproduction of the physical property should include every item of expense which would enter into the cost of reproducing the property as it existed on the date of the appraisal, they are proper terms to include in the appraisal. As to whether the fixed rates were high enough in every case, is an open question.

The Charge of Ten Per Cent. for Contingencies.—Perhaps no single feature of the Michigan appraisal of physical property has been so generally criticised as the charge of 10% of the entire estimated cost, including all the percentage charges, to cover "contingencies."

At the time the first appraisal was made, the writer was not at all satisfied that such an item, in such amount, should be included. The reasons advanced were so strong that it was done, and the writer's subsequent work has fully convinced him that it was proper and justifiable, because:

(*a*) The conditions under which this particular inventory and appraisal were made, as to time and lack of co-operation of the companies, made it practically certain that some items of value were missed in the appraisal, such as station and miscellaneous equipment, frogs, switches, track structures, buildings owned by the companies and occupied by others, etc.

(*b*) That there were many and large elements of physical cost not ascertainable by a physical inspection, such as deep foundations, many thousands of yards of earth in swamps and sink holes (a very general condition of roads in the Southern Peninsula), concealed classification due to growth of grass or washing of banks, and many other cases of work actually done, invisible after a lapse of years. The writer knows of many such instances on property which was in his charge many years ago; in several cases there were expenditures of from $20 000 to $50 000 which are now entirely invisible to an engineer passing over the line.

(*c*) The failure on the part of railroad companies to keep anything like a complete history of construction operations, and the changes of operating officials from year to year, cause the loss of record of practically all the expense due to extra hazard and risk which the construction engineer provides for by his "contingencies."

(*d*) The inclusion in operating expense, every year, of sums which are properly construction, and which, if added to unit prices of construction work, would cause the cry that such unit prices were too high. For instance, the appraisal estimate on earth was 17 cents per cu. yd., with no allowance for overhaul. Very much of the grade in the State had actual costs far in excess of this figure, and practically every road spends a large sum annually for the first four or five years, which is charged to operation but is in reality a part of the cost of completing the roadbed.

(*e*) No account was taken of appreciation of any of the elements entering into a road. There is no doubt that roadbed, for example, does appreciate, due to ballasting and track work. These items go far toward accounting for the contingencies item on an old road such as the Michigan Central.

(*f*) There is a considerable amount of cost, which cannot be taken out of capital, where facilities are abandoned or line or grade changed. These changes are common to all growing roads; they are due to the demands for greater traffic; they are necessary to the welfare of the community served; they are often made at points where no charge of defective design will apply. They might be termed expenses due to the development of the State, and, in the development of the railroad business, they were absolutely necessary for its present standard of efficiency. They are incapable of exact and definite determination, and must of necessity be included as contingent expenses.

In the case of a new road, where the exact cost is ascertainable, the records have been fully kept, the original plans are on file, and the history is fresh in the minds of the officials, it will be readily admitted that a charge for contingencies in large amount would not be justifiable; but, in the case of the Michigan Central Railroad, a line more than 50 years old, which has changed, rebuilt, and added largely to its property; in the case of the Pere Marquette Railroad, made up of the union of a dozen lesser properties, without any complete history; in the case of dozens of little lines, without maps, profiles, or records, some such allowance is fully justified and proper.

The experience of the writer, in the years that have passed since these appraisals, leads him to the opinion that the difficulty of estimating values on an old property are such that in many cases an appraiser might add, with perfect propriety, even more than 10% for the contingency item.

In computing overhead charges, no allowance was made for working capital, and no addition to the physical valuation was made to cover any such element as "going concern" value.

Right-of-Way Values.

Land values were the subject of a great deal of discussion during the appraisal of 1900, but subsequent investigations as to actual railroad purchases resulted in quite radical changes in some of the figures in the later valuations. In view of the fact that many criticisms of these values have been made by railway attorneys, special emphasis is here given to the subject. The conclusions reached in Michigan in 1902 agree so closely with the conclusions of Taylor in Wisconsin and Morgan in Minnesota that it is thought advisable to give a rather full account of the methods used in both appraisals, and the line of reasoning which brought about the changes made in 1902.

The 1900 appraisals methods were as follows: Work in Detroit, Grand Rapids, Saginaw, Bay City, and some other large cities was assigned to special appraisers, who visited the cities, examined critically all the property, conferred with leading real estate men and experts in values, and placed an estimate per acre or per square foot. This part of the work was done with great care, and was substantially unchanged in the later appraisals.

In all other land valuations, in cities and villages, and country right of way, a personal examination was out of the question without making a very large and expensive addition to the staff, as the field engineers generally were not familiar with realty values, and could not take the time to make the large number of inquiries. The appraiser did not see his way clear to organize a special department, therefore the matter was turned over to a sub-department of the Civil Engineering Section, the work of which may be briefly outlined, as follows:

Lands were classified as:

(*1*) Farm land,
(*2*) Barren land,
(*3*) Villages having a population of less than 500
(*4*) Villages from 500 to 3 000,
(*5*) Cities having less than 10 000,
(*6*) Cities having more than 10 000.

The percentage of waste land was fixed as a result of interviews with roadmasters, superintendents, and other officials and employees of the roads, by reports from field inspectors and others.

Letters of inquiry were sent to real estate men and bankers in every county in the State (some 500 being communicated with), as to land values in the town or county of each. The responses, which were numerous and indicated considerable care in preparation, were classified, and on these data, supplemented by as much personal inspection as it was possible for a few men to give in a limited time, the values of the various classes of land were determined by a system of averages. The naked land values were then taken, and to them were added, as follows:

South of a line east and west through Saginaw, 125% plus a fixed charge varying from $8.50 per acre downward was added to the so-called naked land values for farm land. No waste land values were considered in this district. North of this east and west line: Farm land, 100% and a fixed charge of $3 per acre and upward; waste land, 200% plus a fixed charge of $3 per acre; for all village lands, 125% plus $8.50, fixed charge; for all city lands, 100% plus $8.50, fixed charge.

The fixed charges were intended to cover the expense of acquiring abstracts, recording deeds, etc. Slightly different figures were made for the Upper Peninsula.

The result of this work was a set of very low figures in many counties, the average price per acre hardly reaching the going price of improved farm lands. There was so little time to review these figures after they were in shape that they were used in 1900, although the appraiser was convinced that they were generally too low.

In the appraisal of 1902 a very careful study of real estate values was made. The offices of Registers of Deeds in ten or twelve counties were visited, a careful abstract of all railway transfers for a period of 10 years was taken off, the acreage determined, the average price per acre for different classes of land computed, and then a very careful study of transfers of adjacent improved and unimproved lands was made. As a result, material increases were made in the farm land values, waste land values were eliminated, the 1900 valuation, made by special appraisers in large cities, was practically unchanged, while very radical changes in the way of equalization of values of lands in villages and small cities were made.

Inasmuch as the 1902 valuation was at issue in the Courts, the writer believes he is justified in discussing at some length the deduction of the staff on the conclusion of the 1902 preliminary studies, which led to the final adoption of the new figures.

One would fall into error if country values for farm purposes were conflicted with country values for railroad purposes. There is, undoubtedly, a close relationship between the two classes of values; this the writer has endeavored to discover, and it is indicated in Tables 2 to 6. The use to which land is put can and does change its value. Farm land in a certain township may be worth $50 per acre for farming, but the discovery of oil would affect values, as far as oil purposes are concerned. The presence of a vein of coal would give a distinct value for mining purposes. Farm prices would not govern values for any special use, such as oil drilling, mining, or railroad operation.

In the case of city business property, farm prices cannot be applied, as the use to which the land is put and the buildings placed on it give it a greatly increased earning power, and hence increased value. Thus, with a railroad right of way, the continuity of the strip of land, the severance of lands crossed by it, the greater earning power it derives from the construction placed on it, in short, the uses to which it is put, give it a value far in excess of adjoining lands. An excellent proof of this is found in the fact that many thousands of miles of right of way have been bought by promoters and either sold to a company, which built the lines, or used in financing the road. In no case has the selling price been based on farm values.

It is not contended that railroad land values do not bear a direct relation to land values for other purposes, as those things which tend to increase general values usually make the construction of a railroad profitable, and the better and more fully developed the country, the greater is the need for transportation facilities and the higher the prices of land for all purposes. This is shown in the figures submitted herewith.

For purposes of appraisal, therefore, in 1902 the average value, as derived from the 1900 appraisal, was taken, and, by comparison with actual purchases, an attempt was made to ascertain the relation existing between the appraisal figures of 1900 and the usual purchase price for railroad properties, as determined by actual transfers. In making these figures the appraiser was forced to the following conclusions:

(*1*) That the naked land value is not a proper one to use in country lands, but that the going value of country lands with all improvements should be used as a basis for computing the added increment due to railway use;

(*2*) That a classification of farm land and waste land should not be made, except as a basis for arriving at the relative differences in quality of land in different sections of a county;

(*3*) That the added value for railroad purposes is due to the three elements:

  (*a*) Continuity,
  (*b*) Severance or damages,
  (*c*) Changed earning power,

all of which the farmer or owner has cognizance of in making his price;

(*4*) That in making up land values, account should be taken of:

  (*a*) The cost of acquiring the land, or expense,
  (*b*) Cost of the land itself.

The reasons are:

I.—In making a price on a 40-acre farm, the owner does not make two prices, one on land and one on improvements. He arrives at a flat price per acre for the entire farm, and usually asks more per acre for a part than the whole. A man who valued his land at $100 per acre, with improvements, would hardly sell 5 acres from a corner of his land, even for residence purposes, at naked land prices.

The 1900 appraisal was based on naked land prices, as estimated by a number of citizens of each county, and this flat rate was used in making figures for the so-called "Market Value of Right-of-Way." It is fair to assume that a railroad company can purchase large tracts of land for gravel pits, or a narrow strip adjoining and widening its existing right of way, at about market prices, as the elements of severance, abutting damages, etc., are absent. Prices for this class of land ought to be, and usually are, lower than those paid for a new right of way.

TABLE 2.—COUNTRY LAND.—ADDITIONAL STRIP FOR WIDENING RIGHT OF WAY, GRAVEL PITS, ETC.

County.	Description: Road and purpose.	Average per acre, 1900 appraisal.	Average per acre, transfer.
Jackson	Michigan Central. Widening right of way	$84.47	$156.08
Kalamazoo	Michigan Central. Additional right of way near Augusta	89.41	140.00
Kalamazoo	Grand Trunk Western. Additional strip for double tracking	94.59	120.50
Cass	Michigan Central. Gravel pit	84.97	94.15
Cass	Grand Trunk Western. Additional strip for double-tracking	71.79	203.53
Berrien	Michigan Central. Additional right of way	109.40	113.66
Washtenaw	Michigan Central. Additional right of way	49.35	130.68
Washtenaw	Ann Arbor. Additional right of way	88.60	116.12
Ionia	Pere Marquette. Gravel pit	77.50	125.00

Actual purchases are averaged from recent transfers, and represent consideration paid owners, but not cost of acquiring.

The 1900 appraisal averages show country land after fixed charges and percentages are added.

The tables given herewith are summarized from a very large mass of information introduced as evidence in a suit of Michigan Central Railroad *et al. vs.* Powers (The Michigan Tax Cases), and are selected as average examples of conditions throughout the Southern Peninsula.

It is evident from the figures in Table 2 that no such naked land values as those used in 1900 were considered by the farmers in placing values on their lands, as the sales covered in that table do not involve any large element of damages. All transfers are of a strip a rod or more in width adjoining an existing right of way.

II.—It is true that in some sections of Michigan there are large tracts of barren or low-priced land. In 1900 barren land prices were used, and were much lower than farm land; in the poorer parts of the State large percentages of barren land were used. This fact brought the average per acre of country land, as applied in the appraisal, very low in many of the counties, and justified the appraiser in using the average country price of 1900 as the base price for a revaluation. Generally, the 1900 appraisal averages for country lands were fair indices of the difference in actual value in different parts of the State.

In the 1900 appraisal, the Michigan Central was credited with having, in Jackson County, 309.1 acres of farm land (naked value, $38, average rate $93.30), and 34.35 acres of barren land at $5 per acre. The field inspectors reported that part of the district between Parma and Albion, in the vicinity of Bath Mills, was waste or barren land. The Jackson and Battle Creek Traction Company parallels and adjoins the Michigan Central Railroad right of way from Parma to Bath Mills. An investigation of records of deeds showed that they bought 25.02 acres of land in this district at $65.79 per acre, and that the average price of all their land in the county was $239.52 per acre.

While there was a marked difference in the rates of different grades of country land, no one would be justified in putting any land south of a line drawn from Saginaw to Muskegon at prices as low as $2 to $10 per acre. An average based on the 1900 classification of lands would probably eliminate all waste land classifications, without doing any injustice.

TABLE 3.—AVERAGE VALUES PER ACRE OF COUNTRY LANDS, OF THE 1900 APPRAISAL, OF THE JACKSON, LANSING AND SAGINAW RAILROAD, AFTER ALL THE PERCENTAGES AND FIXED CHARGES WERE ADDED.

County.	Price.	County.	Price.
Jackson	$75.71	Ogemaw	$8.69
Ingham	74.90	Roscommon	10.74
Clinton	42.38	Crawford	8.41
Shiawassee	67.18	Otsego	15.62
Saginaw	40.80	Montmorency	12.38
Bay	38.69	Cheboygan	17.13
Arenac	32.47		

Table 3 illustrates quite clearly the extremely low figures applied in many counties in the 1900 appraisal, and also represents quite well the relative difference in value in the different counties.

That the 1900 rate varies about as the purchase price, is shown by the fact that the Pere Marquette Railroad built a line in Montcalm County, buying 155.3 acres at an average price of $135.19 per acre, while the 1900 appraisal showed an average of $29 on the 918 acres appraised. The purchase price was 4.66 times the 1900 appraisal.

In Calhoun County, the Grand Trunk Railroad bought 63.2 acres at $491.13 per acre, while the 1900 appraisal was $61.44 on all the country land in the county, or only one-eighth of the actual purchase price.

III.—There can be no doubt that a railroad right of way costs much more than an equal acreage of farm lands. The writer has always been inclined to hold the view that an ordinary right of way through good farming country would cost from two to three times farm prices, no matter how much care is used in the acquisition of the land. In recent years the price of right of way has been greatly increased. The Newton and Northwestern Railroad right of way, in Iowa, cost $267 per acre, on a line 80 miles long. This is nearly all country land, about 1 mile in the outskirts of Boone (population 12 000), and about ½ mile in Newton (population 6 500), being the only city land to increase the average. The Rock Island System and the Chicago Great Western paid higher country prices in the same territory. This line is in such country as Southern Michigan, and land is held at from $65 to $100 per acre.

The Toledo Urban and Interurban right of way, in Lucas County, Ohio, was bought by the writer in 1904 at an average net price of $329.21 per acre. The average assessed valuation is $55 per acre. The going value of farm lands will range from $100 to $225; probably a fair average is $135 per acre. The prices paid by Michigan railroads are fully sustained by these personal experiences.

The figures in Table 4 show that the actual average price paid for new right of way is greater than the average of the 1900 appraisal, after the 125% and fixed charges are added, by from 230 to 726 per cent.

The argument that a change of line costs more than a new line is not sustained by Table 4. In Jackson County, the Michigan Central Railroad changed its line at an average cost of $165.67 per acre. The Jackson and Battle Creek, a new line, parallel with and adjoining the Michigan Central, paid $239.53; the Jackson and Suburban, a new electric line, paid $293.34, and the "Ypsi-Ann" Electric paid $393.74. All the new lines in Monroe County are higher than any changes of line in similar country. The Ann Arbor change in Washtenaw County, located by the writer, is at one point 3 miles from the old right of way, and only at the two ends of the 7-mile line does it run on farms owned by parties crossed by the old road; therefore, to all intents and purposes, it is a new line.

The naked land values used in 1900 being clearly too low, were of no use and were dropped. The so-called market price of right of way as given in 1900 was misleading.

TABLE 4.—Comparison of Country Land Values.

The actual purchases are averaged from recent transfers, and represent consideration paid to land owners, but not the cost of acquiring.

The 1900 appraisal averages show all country land after fixed charges and percentages were added, per rule of 1900.

County.	Railroad.	1900 Appraisal, average per acre.	Railroad.	Actual transfer, average per acre.
Jackson... ..	Michigan Central Air Line.....	$71.36	Michigan Central Air Line. New Line....................	$165.67
	Michigan Central..............	88.47	Jackson and Battle Creek. Average entire county......	239.53
	Michigan Central. Waste land.	5.00	Jackson and Battle Creek. Waste land......	65.79
	Michigan Central. First-class farm.........................	93.30	Jackson and Battle Creek. First-class farm.............	293.51
	Jackson, Lansing and Saginaw. Average country values.....	75.72	Jackson and Suburban........	293.34
			Detroit, Ypsilanti and Ann Arbor..	393.74
Monroe......	Flint and Pere Marquette......	93.30	Flint and Pere Marquette. Monroe to Toledo............	215.21
	Michigan Central..............	93.30	Toledo and Monroe. Electric	461.13
	Lake Shore and Michigan Southern.....................	93.30	Detroit and Toledo Shore Line (Duffy)....................	214.38
			Detroit and Toledo Shore Line (Burt).......................	262.49
Kalamazoo ..	Michigan Central..............	89.41	Michigan Central. Kalamazoo to Mattawan	236.22
Van Buren...	Michigan Central..............	66.54	Michigan Central. Kalamazoo to Mattawan................	196.00
Cass.........	Michigan Central..............	84.97	Michigan Central. Cut off near Pokagon................	260.61
	Michigan Central. Waste land.	10.00	Michigan Central. Waste on cut-off......................	60.00
Genesee......	Grand Trunk Western.........	98.10	Grand Trunk Western. Improved line..................	337.56
Genesee......	Pere Marquette................	80.84	Flint and Pere Marquette. Change of line...............	234.00
Montcalm....	Pere Marquette................	29.00	Pere Marquette - Greenville Stanton.....................	135.84
Calhoun	Grand Trunk Western.........	61.44	Grand Trunk Western. Change of line west of Battle Creek........................	491.13
Calhoun	Michigan Central..............	71.38	Jackson and Battle Creek. Electric.......................	218.74
Tuscola......	Michigan Central.............	60.75	Michigan Central. Caro-Owendale........................	73.04
St. Clair.....	Pere Marquette......	43.18	Rapid. Anchorville - Marine City	287.05
Washtenaw .	Ann Arbor.......................	38.60	Ann Arbor. Change of line near Ann Arbor............	285.50
Ionia	Pere Marquette................	77.50	Pere Marquette. Lowell-Belding..........................	112.30
Manistee	Ann Arbor..........	25.40	Ann Arbor. Change line near Harlan	47.33
Osceola	Pere Marquette................	40.03	Pere Marquette, Change line near Evart	57.93

Having shown that there is an increase in cost of railroad over farm land, the question arises: Is it legitimate? If it is a proper item of cost, has it a place in the present value column?

In building a new railroad, engineers prepare their estimates of cost, including grading, rail and fastenings, ties, bridges, and, among other items, right of way. Their clients provide funds to build the line, and furnish, among other items, cash for the right of way. The right-of-way account in no wise differs from that of any other item of physical cost. The right of way, with all its hold-ups, items for damages, court costs, legal expenses, bills for personal services and expenses in securing it, abstracts and recording of deeds, is just as much an element of physical cost as the rails. The cost of acquiring the right of way is as proper an element as charges for inspecting the rails, freight charges on them, the loading and unloading, or any other charges that enter into the cost of rails delivered to the track-laying contractor.

Should the cost of reproduction of right of way be carried to the present-value column? Clearly, yes. If a road is unfortunate enough to buy its rails when they are at a price of $60 per ton, the full price is charged to capital account; and when the line is sold to some large corporation, no reduction is made, even though the price of rails be much less at the time, but the selling price is based on the construction account as a whole.

The same is true of the right of way. In no case which has come under the writer's notice has a new company, or a set of promoters disposing of a new line or a new right of way, ever consented to deal except on the basis of construction account, plus promoters' profit The cost of a right of way is increased on account of continuity. A farmer is justified in increasing his price per acre by reason of the fact that the road must have a continuous line, regardless of how it affects the individual. He must rearrange his fields, replant his orchard, change his fences, ditches, and tile lines, and re-adjust his entire property to accommodate the necessity of the road. He must also take into account severance or damages. He is compelled to cross the line at an inconvenient place, open and close two gates in every lane or at every crossing, drive his cattle back and forth to water, haul his produce over a short heavy grade across the track, and he must not interfere with the railroad. He is in constant danger of loss of property from fire or from accident, and he is in personal danger every time he passes from his own land on one side of the railroad to his own land on the other side. Every one who has bought right of way knows these arguments, and is aware that the farmer knows them and charges extra on account of them.

The law provides that, in condemnation, the jury shall take into account two elements, the value of the land, and damages. The railroad pays them, and very promptly charges the entire cost to the right-of-way account. No one will question the propriety of the farmer taking them into account in fixing his price. The value of continuity to the railroad can hardly be measured in dollars and cents.

A fair illustration of continuity may be found in coal lands. A promoter will secure option on a large acreage. As long as his holdings are disconnected and widely separated they are of no more value than adjoining lands, but let him close options on a large block of land all in one body, and immediately he can add from 100 to 200% to the value of his land for mining purposes. This added percentage is due to continuity.

The conditions surrounding the purchase of railway lands in Michigan have changed materially in the past few years. In a new country, without means of transportation, land values are low, and, in order to open new markets, land owners can afford to donate the right of way. Undoubtedly, a very large percentage of the total right of way on the older lines was either donated or bought at very low prices. As a community grows and develops, acquires new industries, and receives new improvements, property values increase; and, along with a general appreciation of other values, those of railroad property must increase. It would certainly be true that the present value of the site of the Majestic Building, in Detroit, is not the same as it was in 1850; the argument that its actual cost in 1850 was, say, $200, would not be any justification for such a value to-day. Equally is it true that the value of property owned by the Michigan Central Railroad is not to be measured by the price paid for it 50 years ago. The greater business, and the larger income derived from that business, make the Detroit of to-day a much more valuable terminal for the road than the Detroit of 50 years ago.

The same argument will apply to any city which has grown up after the construction of railroads. The original right of way was farm land and may have been a donation, but the change from farm to city certainly increases the value of the railroad land just in proportion as the surrounding land increases.

The same reasoning is properly applicable to lands which decrease in value. Where a railroad buys right of way to gain access to valuable timber lands, and, after the removal of the timber, the land is too poor to support a population, the present value should depreciate in the same ratio as the surrounding land, and immediately on its abandonment as a right of way it would cease to have a railroad value.

In an appraisal, it appears to be fair to base the cost of reproduction on the cost of building a new line on the location of the road under appraisal, all other means of transportation remaining as they are to-day, so as to secure as nearly as possible the conditions that would be encountered by a new company building a new line on this location.

The argument was made in 1900, and reiterated frequently, that railroad companies secure many donations. It may safely be said that, in a developed country, such as in the south half of the Lower Peninsula, the donations are of little account. Few donations were found in an examination of records of deeds covering 10 years; and in some cases the conditions were so burdensome that it may be said that the gift land was the most expensive. A condition for a cattle-pass costing from $400 to $600, a side-track costing from $1 to $1.50 per ft., and other like specifications are found; and in many deeds where a liberal consideration is named conditions which add greatly to the cost are not infrequent.

The recent new lines in Southern Michigan secured but few donations, although all considerations of $1 and other good and valuable considerations were classed as donations unless the contrary was susceptible of proof. In the case of the Ann Arbor Railroad, in Washtenaw County, the $1 consideration represents a higher price than the average, this being known by the writer, as he bought it. The same is true of the Detroit and Toledo Shore Line, in Monroe County. In making an appraisal, no deductions should be made for donations, if there are any, as the fact that land is donated does not indicate absence of value; nor should an addition be made to the appraisal value on account of the fact that a road has been held up and compelled to pay exorbitant prices in certain localities.

In some counties the base values of land in villages and small towns were given at ridiculously low prices in 1900; some are as low as from $50 to $100 per acre in towns of from 1 000 to 3 000 population. When one stops to consider that a lot 4 by 8 rods contains $\frac{1}{5}$ acre and that such lots in a town of considerable size range from $50 to $300 each, it is readily seen that from $250 to $1 500 per acre are not excessive figures. The figures for an adjoining county were often very high, and village values were put up to substantially full value. The result of adding percentages in 1900 was to magnify discrepancies, and little villages of from 200 to 500 population in one county were appraised at a higher rate than towns of from 2 000 to 5 000 in the next.

In 1902 the appraiser undertook to equalize all such discrepancies, and found that no hard-and-fast rule would apply. A comparison of village values, as determined by actual purchase, with the 1900 appraisal, is given in Table 5.

The 1900 appraisal for city lands, outside of Detroit and Grand Rapids, was generally very conservative or low. In some cases the figures were extremely low.

TABLE 5.—AVERAGE PRICE PER ACRE FOR VILLAGE LAND.

Actual purchases are averaged from recent transfers. The 1900 appraisal averages are averages of prices as applied after all percentages and fixed charges are added.

County.	Name of road.	Name of village.	Appraisal, 1900. Average per acre.	Actual transfer. Average per acre.
Jackson	Michigan Central	Parma	$177.25	$1 166.65
Van Buren	Michigan Central	Mattawan	571.00	2 439.04
Tuscola	Michigan Central	Caro	571.00	733.42
Oakland	Pere Marquette	Clyde	346.00	333.00
Oakland	Pere Marquette	Milford	571.00	1 136.37
Genesee	Pere Marquette	Grand Blanc	121.00	327.87
Kent	Pere Marquette	Lowell	571.00	1 552.26
Ionia	Pere Marquette	Belding	1 000.00	967.77
Washtenaw	Michigan Central	Dexter	571.00	718.75
Washtenaw	Michigan Central	Delphi	233.50	2 383.34
Cass	Grand Trunk Western	Cassopolis	458.50	1 600.00
Cass	Grand Trunk Western	Edwardsburg	222.25	466.67

The conclusion reached by the appraiser in 1902 was that, for railroad purposes, right of way is worth what it costs to produce it. It would be just as consistent to claim that a railroad has a misfortune in having a river to cross, and that no value should be placed on the bridge which spans it, as to claim that right of way, which costs three times farm-land values, should not be valued at a higher figure than farm land.

TABLE 6.—Comparison of Valuation Figures with Actual Considerations.—Comparison of Immediately Adjoining Properties, Grand Rapids, Michigan.

The prices are per square foot or per acre.

Location.	Size of lots.	Michigan Central appraisal.	Pere Marquette appraisal.	Actual transfer.
Fulton to Island Street	50 by 100 ft.	....	$2.00 per sq. ft.	$1.40
Island to Oakes Street	50 by 100 ft.	....	2.00 " " "	1.22
Oakes to Cherry Street	....	....	2.00 " " "	1.33
Cherry Street Frontage	130 ft. deep	$1.23 per sq. ft.	1.23 " " "	....
Cherry to Williams Street	50 by 130 ft.	....	....	1.55
Williams Street Frontage	130 ft. deep	0.92 " " "	0.51 " " "	....
Williams to Bartlett Street	....	....	....	0.76
Bartlett Street Frontage	130 ft. deep	0.77 " " "	0.46 " " "	....
Bartlett to Goodrich Street	....	....	....	0.62½
Goodrich Street Frontage	130 ft. deep	0.62 " " "	0.38 " " "	....
Goodrich Street to Wealthy Avenue	....	....	....	0.39½
Prescott to First Street	....	0.25 " " "	....	0.54
First to Second Street	....	0.25 " " "	....	0.16
Land on Hall Street	....	1 500 per acre	1 359 per acre	3.75
North side of Hall Street	....	....	1 000 " "	....
Hall to Stevens Street	....	1 500 " "	800 " "	1 351.11 per acre
On Crofton Street	....	400 " "	....	400.00 " "

The problem of an appraiser is to determine, with the best evidence at hand, what land is fairly worth for railroad purposes at the time of appraisal. He must take into account the railway-purpose increment, if he is consistent in his appraisal.

Non-Physical Values.

The foregoing narrative account of the general field and office handling of the Michigan appraisal of physical property, while not touching on matters of principle of valuation, except as to land values, is submitted as describing briefly the machinery of the appraisal. A number of very important issues were raised which have to do with the theory of valuation. These are worthy of discussion at length, in the subsequent consideration of the method of determination of a fair value, but are not here referred to. Within any short limits it is impossible to give a comprehensive description in detail of all the work of the Michigan appraisal. Several articles descriptive of this work have been written, giving quite full extracts from the various sets of rules which were promulgated, and describing some phases of the work in much more detail than is here attempted.

The physical valuation, as represented by two figures—the cost of reproduction of the physical property, and its present value—was submitted to the Board of State Tax Commissioners as the work of Professor Cooley, and in most of the literature descriptive of it, it has been termed the "Cooley Appraisal."

After the completion of Professor Cooley's work, his figures were submitted to Professor Henry C. Adams, who had been making a study of the income accounts of the various companies, and to whom had been assigned the duty of determining the non-physical or franchise values of the properties.

Professor Adams has described* very fully the plan adopted for this work, and this plan has been commented on so fully that any lengthy description is deemed unnecessary. It appears to be perfectly proper, however, to correct certain misstatements regarding this work.

When it was first determined to make the appraisal Professor Cooley—not Professor Adams—was requested to take charge. The assignment to Professor Adams of the non-physical valuation was made after the physical valuation was well under way.

The use of a negative or subtractive non-physical value was considered, and advised by Professor Adams. The work was not undertaken with a view of "increasing the assessments," but to put the Tax Commission in possession of a figure which would represent the business value of the property as well as the physical value.

Professor Adams held that the non-physical element of value was not a simple commercial element, but included:

The franchise { to be a corporation,
to use public property,
The possession of traffic not exposed to competition,
The possession of traffic through connections,
The benefit of economies due to density of traffic,
The value due to organization and vitality of industries served.

He also held that, as nothing visible or tangible gave support to this value, it must be determined on the basis of information secured from the income accounts of the company.

---

* Bulletin 21, U. S. Bureau of the Census, p. 78.

Without going into any complete description of Professor Adams' method, it may be said that he made an analysis of the income accounts, and, after providing for operating expenses and taxes, he deducted, as an annuity properly chargeable to capital, a certain percentage of the appraised value of the physical properties. Any remainder was capitalized to give the true value of the immaterial element, or the business value.

In the rates of capitalization and annuity used in 1902, there were certain changes, making them differ from those used in 1900, and certain changes in the detail of analysis of income accounts and methods of determining the rates of interest which are entirely immaterial to the present narrative. The work was of great importance as being the first exposition of this method of obtaining non-physical values. It was a fair, logical, and business-like attempt to determine those elements which give a well-designed, economically-built, or advantageously-located property a greater value as a money-earning concern than the actual capital invested, or than the actual value remaining in its physical property.

It will be seen that, in the case of a property in which the surplus earnings depend on excessive rates for service, it will fail as a method of determining a value for use as a basis of rate-making; and it fails, in the form in which it was used in 1900 and 1902, to bring out those negative or subtractive elements which may be determined from the income accounts, in the case of properties which do not earn a fair return on the investment. This, however, was due to the fact that the taxation laws of Michigan made no provision for any reduction of value because property was idle or non-productive, and any such deduction in the case of corporation property would place it on a different basis from other property. Professor Adams and his associates, therefore, applied only positive values, where any such were found, although advocating the use of negative values.

The writer has seen no criticism of Professor Admas' work which is not apparently incited by, either the direct interest of corporations in lowering valuations for taxation, or by an effort to confuse the subject of valuation so as to discredit the work in the eyes of taxing authorities. Any person competent to discuss the matter, who has given Professor Adams' method careful thought, will be forced to the conclusion that this was a long step in the direction of the final solution of these important and perplexing elements of value.

History and Results of the Michigan Appraisal.

Based on the valuation of 1900, the Board of State Tax Commissioners was enabled to comply with the statute in reporting to the Legislature. New laws were passed, sundry suits were brought, and, finally, the case of the Michigan Central Railroad *vs.* Perry F. Powers, Auditor-General, and a number of other cases in behalf of other roads, were brought to trial before the United States Court for the Western District of Michigan.

This Michigan Central case was a suit to restrain the collection of taxes based on the new assessment, the railroads claiming that their property was assessed at full value, while general properties of the State were assessed at a considerably lower percentage than full value. This suit was essentially a valuation of the railroad properties as of April, 1902. This work was done along the same line as the former valuation, by a portion of the same staff. The old work was brought down to date, and certain special studies were made, which resulted in a change of right-of-way valuation, as has been related.

In the trial of the case of Michigan Central Railroad *vs.* Powers, the two valuations were fully testified to by all the men engaged, and the record relative to the appraisal fills several volumes.

Subsequently, in 1906, Professor Cooley was engaged by the Attorney-General, and, re-assembling the staff, brought the work down to date as of April, 1906.

There has been no permanent force engaged on the work in Michigan, and the re-appraisals have only been made as actual necessity demanded.

Market Value of Stocks and Bonds.—During the progress of the appraisal of 1900 an independent force of men was engaged in studying the market values of stocks and bonds of Michigan roads with a view to securing information on every possible line that would aid the appraiser in reaching proper conclusions, or enable him to check his figures. These figures were used only as a check, and no report of the details of this work was submitted.

Error in Published Reports as to Michigan Work.—In several articles descriptive of the Michigan work, one quite serious misstatement of fact has inadvertently been made. The writer is not quite sure how or where the wrong impression originated, but it has been noted in several articles and editorials.

Substantially, all accounts are similar to that of Professor Taylor,* which is:

"In looking over the notes and results of the work done in Michigan, it was noticed that Mr. Cooley's engineers, car-men and other experts went over the property of each railway company and enumerated and valued the same, and then the railway company generally had its own men perform the same work in order to check up the appraisal made by the State authorities. Thus, this expensive work was unnecessarily duplicated."

Undoubtedly this statement was made in good faith, and has gained currency by not having been corrected, but it is not the fact.

The Chicago and Northwestern Railway took immediate steps to make surveys and secure data, as has been described, and made a complete appraisal, using the Michigan forms. The result of this appraisal was:

Chicago and Northwestern, present value.......	$8 551 530
State appraisal, present value..................	8 281 090

In this case the railroad had no records, and the work was of value to them, not only as a check on the work of the State, but also as giving them complete records of permanent way. It was not done independently of, and after, the State work, but was organized so that the field work of both railroad company and State was done at the same time.

No other complete work of valuation was done by the railroad companies. During the trial of the cases, no contrary or different valuations were set up. No special attack was made on the work, except to select here and there some specific example of a building which was appraised at a higher figure than cost, perhaps half a dozen in all, and to introduce expert evidence, particularly on land and right-of-way values. Aside from the money expended on the litigation, there were no expenditures by the roads in checking up the work. On the contrary, a number of managers, at their own expense, had typewritten copies of the final report as to their own lines made, in order to file in their records.

It is a fact that only one of the seventy-eight roads made a complete appraisal, covering 387.8 miles of main line, and none of the other roads or mileage went to any considerable expense.

---

* Bulletin 21, U. S. Bureau of the Census.

The Cost of the Work.—No complete statement of the total cost of the work of valuation in Michigan has ever been issued as a public document. The cost of the work, including salaries of appraiser, engineers, assistants, clerks, all expenses of the Board of Review, all expenses connected with Professor Adams' non-physical appraisal, also all office rent, stationery, supplies, telegraph, telephone, and railroad expenses, printing and binding—in short every dollar chargeable to the Michigan railroad appraisal of 1900 footed up to $70 604.21.

The exact mileage of roads in the State was:

Main track	7 082.35	miles.
Second track	164.83	"
Branches	730.92	"
Spurs and sidings	2 904.70	"
Total	10 882.80	miles.

Average cost per main-line mile	$9.97
" " " total-track "	6.50

The exact figures of cost of the subsequent work of appraisal, or the costs of the litigation, are not available to the writer. In a general way, it may be said that the cost to the State of the railroad tax cases was not far from $75 000, and that the expenses of the second and third appraisals were less than $50 000, so that, to date, the entire cost to the State of Michigan is less than $200 000 for the three appraisals and the litigation growing out of them.

Some information as to details of costs may not be out of place. All employees were paid a salary and required to provide their own subsistence. Salaries ranged from $250 to $500 per month for experienced men, from $125 to $250 for men with only a few years of experience, and from $75 to $125 for assistants and clerks.

All traveling expenses (except hotel and subsistence) were paid, the State issuing mileage books to all employees, and receiving a complete check on the movements of every man through the mileage bureau. The telegraph and long-distance telephone were used almost exclusively in communication between the office and the men in the field, all bills being paid by the State. All expenses of inspection by hand-car, velocipede-car, etc., were paid by the State, except as the roadmasters made trips with the inspectors.

The unvarying policy of the appraiser was to reimburse the companies for all extra expenses incurred on account of the work, and to accept no transportation or favors from any company.

The Result of the Michigan Work.—Any undertaking must be judged by its results. The Attorney-General's report for 1906, on pages 21 and 23, states:

"These cases are among the most important in the history of the State. They constitute the last step in subjecting railroad property in Michigan to taxation on the same basis and at the same rate as other property is taxed, and secure practical uniformity and equality of taxation between railroad and other property.

"As a result of these cases the various railroad corporations paid in taxes $4 787 478.15, and as penalty thereon $1 158 321.18, a total amount of $5 945 799.43 for the years 1902, 1903 and 1904. The 1905 tax being paid soon after the decision of the Supreme Court, nothing was paid under the former law (specific tax on earnings) and, of course, there was no penalty on the 1905 taxes as they were paid before May 1, 1906."

In short, the roads are paying to the State of Michigan an average of $1 595 826.05 more per year than they paid under the old law, and to date the State has received about $10 750 000 more from taxes than it would have received under the old specific tax law.

Railroad development in Michigan has received no appreciable check, and notwithstanding a 2-cent fare and the bearing of an equal burden of taxation, the properties are maintained, and improvements, double-tracking and betterment of general standards fully keep pace with similar work in other States.

Of course, it must be recognized that other forces besides the appraisal helped to bring this about. The appraisal of 1900 furnished the information. Public opinion compelled the passage of the needed laws, and the magnificent legal work of Attorneys-General Blair and Bird, Congressman Townsend, and Judge Knappen, and their associates, loyally supported by Professors Cooley and Adams and the appraisal staff, were all factors in securing the decision of the Supreme Court of the United States.

Railroad Appraisal of the State of Texas.

Authority for the Work.—In 1893 the Legislature of Texas enacted what is known as the Stock and Bond Law, which was designed to control and limit the total amount of stocks and bonds that may be issued on any railroad property to the "reasonable value of said railroad property." This law further provides that:

"It shall be the duty of the Railroad Commission to ascertain, and in writing report to the Secretary of State, the value of each railroad in this State including all its franchises, appurtenances and property."

TABLE 7.—GRAND SUMMARY OF RAILROAD APPRAISAL OF 1900 AS TO SEVENTY-EIGHT INCORPORATED RAILROADS.

PHYSICAL APPRAISAL.

Item No.	Subject.	Cost of reproduction.	Present value.
1	Engineering, 4% on items 2 to 25, inclusive, and on item 33	$5 386 772	$5 386 772
2	Right of way and station grounds	27 745 313	27 745 313
3	Real estate	863 337	863 337
4	Grading	21 699 995	21 693 024
5	Tunnels	1 148 070	1 093 445
6	Bridges, trestles, and culverts	8 027 119	6 337 819
7	Ties (cross- and switch-ties)	11 139 924	6 148 748
8	Rails	28 703 012	21 865 994
9	Track fastenings	3 845 030	2 987 982
10	Frogs, switches, and crossings	1 469 781	1 040 120
11	Ballast	3 723 558	3 723 558
12	Track laying and surfacing	6 555 638	6 400 972
13	Fencing	2 763 595	1 627 790
14	Crossings, cattle guards, and signs	607 542	428 474
15	Interlocking and signal apparatus	501 883	448 686
16	Telegraph (30) telephones	258 985	134 797
17	Station buildings and fixtures	4 108 736	3 111 103
18	Shops, round-houses, and turn-tables	2 157 228	1 467 569
19	Shop machinery and tools	1 107 910	882 634
20	Water stations	725 670	522 135
21	Fuel stations	303 289	201 461
22	Grain elevators	1 336 794	1 609 043
23	Warehouses	258 646	183 910
24	Docks and wharfs	5 531 919	3 831 934
25	Miscellaneous structures	1 234 345	856 253
26	Locomotives	9 021 517	5 092 053
27	Passenger equipment	3 197 473	2 277 271
28	Freight equipment	19 734 240	13 690 587
29	Miscellaneous equipment	702 940	423 689
31	Ferries and steamships	1 725 000	1 095 500
32	Electric plants	93 061	89 898
33	Terminals		
34	Legal expenses, 0.5% on items 2 to 25, inclusive, and on item 33	673 349	673 349
35	Interest, 3% on items 1 to 34, inclusive	5 290 549	5 290 549
36	Miscellaneous expenses... Organization, 1.5% on items 1 to 34, inclusive	2 645 277	2 645 277
	Contingencies, 10% on items 1 to 34, inclusive	18 428 759	15 127 110
	TOTAL COST OF CONSTRUCTION AND EQUIPMENT	$202 716 262	$166 398 156
37	Stores and supplies	1 474 829	1 474 829
	Average per main-line mile	28 263	23 495
	" " total-track mile	18 627	15 290
	TOTAL VALUE OF NON-PHYSICAL ELEMENT (H. C. ADAMS)		35 814 043

The work of valuation in Texas antedates that in Michigan, and offers some interesting opportunities for comparison of methods under somewhat similar conditions, as far as the existing roads were concerned. The work being in the hands of a permanent commission with very broad powers, it has been possible to secure from recently built roads very full and specific data as to construction, but with these later valuations and with the current work of the department, this paper will not deal.

The Commission of Texas interpreted the law to mean the estimated cost of reproducing or duplicating the properties at the date of valuation, allowing current market prices for all material and fair valuations on all real property.

Method of Physical Appraisal.—The Commission duly appointed engineers to make these valuations. The railroads of the State were unfavorably disposed toward the work, and were inclined to withhold information.

The Texas staff encountered the difficulty due to destruction or loss of construction records, maps, and profiles. They had for their guidance only the profiles, filed under a prior law, and were thus compelled to depend wholly on original field work to secure their data. From a paper by R. A. Thompson, M. Am. Soc. C. E.,* the following description is taken:

> "They [the engineers] with the profiles * * * in hand, made a detailed inspection of the railroads on the ground. The quantities of excavation and embankment, where the actual quantities could not be obtained, were estimated approximately from the profiles, using the center heights of the cross-sections. The classification of the materials in excavation was determined by inspection. Where original plans and estimates of cost of the bridges, buildings and structures of all kinds could not be obtained from the records of the railroads, their value was estimated from measurements taken on the ground. The extent and acreage of the right of way, the depot and terminal grounds, were determined by actual measurement, or from maps furnished by railroads, or from city and county tax records.
>
> "After an examination of a railroad had been made by the engineers of the Commission, its valuation was prepared on estimate sheets. Upon sheets marked Estimate Sheet A * * * were recorded the values of the right of way and depot grounds, roadbed, track, bridges, structures and way building for each mile, the value of ten miles being

---

* *Transactions*, Am. Soc. C. E., Vol. LII, p. 328.

recorded on each sheet. * * * On these sheets space was provided for the units and prices, and columns for carrying out the values for each mile and the totals.

"The value of all rolling stock and equipment, and the value of such properties as were properly applicable and chargeable to the entire railroad, were recorded on a separate estimate sheet, only one sheet being used for a railroad."

It thus appears that the general methods of securing the data and making the field examination were quite similar to those adopted on the Michigan work. The classification of items on the sheets is rather more full than on the Michigan summary sheets, but apparently not so completely in detail as the final compilation of work. In general, however, the physical items included are complete in both cases. The form in which the results are finally put up is radically different.

The following points of variations from the practices of the Michigan appraisal are noted:

(*a*) The unit prices were current market prices.

(*b*) The value applied to right of way and real estate used for railway purposes was in accordance with the current market value of other property immediately adjoining, disregarding donations or property acquired at less than value.

(*c*) No deduction was made on account of depreciation, as it was considered that all structures must be maintained in first-class, serviceable value, and renewed when necessary, and no allowance was made for appreciation of roadbed.

(*d*) No allowance was made for franchise values of any kind, except track rights in streets.

(*e*) No allowance was made for contingencies, except as made in prices or quantities.

Their practice was in accord with the Michigan appraisal, in allowing from 5 to 6% to cover legal and engineering expenses and superintendence, and from 5 to 6% to cover interest during construction.

The Result of the Texas Work.—The object sought in Texas was to secure a capitalization in harmony with the actual investment in the physical property; in short, to "squeeze out water."

Of course, all stock and bond issues outstanding in 1894 are still in existence, except as a few roads have been sold out or re-organized. No new issues of stock or bonds may be made on roads in excess of the valuation. Consequently, new roads are limited to issues of bonds not far from $15 000 per mile. The effect is shown by Table 8, from the Railroad Commission's Report.

TABLE 8.—MILES OF RAILWAY IN OPERATION IN TEXAS, 1894 TO 1908, WITH OUTSTANDING STOCKS AND BONDS.

On June 30th.	Miles of railway in operation.	Stocks outstanding, per mile.	Bonds outstanding, per mile.	Total stock and bonds outstanding, per mile.
1894	9 154	$15 076	$25 726	$40 802
1895	9 291	14 874	25 420	40 294
1896	9 437	14 647	25 302	39 949
1897	9 484	14 320	24 793	39 113
1898	9 540	14 205	24 036	38 241
1899	9 702	13 997	23 562	37 559
1900	9 867	13 724	23 202	36 926
1901	10 154	12 922	22 649	35 571
1902	10 617	12 388	21 779	34 167
1903	11 029	11 971	21 464	33 435
1904	11 495	......	......	32 400
1905	11 662	......	......	33 418
1906	12 056	......	......	32 886
1907	12 577	......	......	32 142
1908	12 830	......	......	32 305

Total reduction, up to 1903, of stock per mile........ $3 105
" " " " " " bonds " " 4 262

Total stock and bonds.... .... $7 367

E. L. Corthell, M. Am. Soc. C. E., speaking of results secured by the Texas law, says*:

"The law, and generally its just operation, has cured many unmitigated and notorious evils. Not only has the public in Texas been benefited, but also the investor in railroad securities from the outside of the State. The people of Texas now have just and uniform rates of transportation, and the investor knows what he is purchasing, and may be reasonably sure of a return on his investment."

Mr. Thompson says†:

"Another significant fact is that only a short time before the Stock and Bond Law became effective about 39% of the railroads in Texas were in the hands of receivers. To-day there is not a mile, of the 11 300 miles in Texas, in the hands of receivers, and, with a few unimportant exceptions, no railroad has been in the hands of receivers since the law went into effect. The fact is that there has been no piece of legislation, in this or any other State of the Union during the past decade, which has been so fruitful of results and beneficent in its action, alike to the railroads and the people."

---

* *Transactions*, Am. Soc. C. E., Vol. LII, p. 346.

† *Ibid.*, p. 364.

Railroad Appraisal of the State of Wisconsin.

The State of Wisconsin made a valuation of railroad properties of the State as of June 30th, 1903, the work being under the direction of W. D. Taylor, M. Am. Soc. C. E. The plan adopted, the methods of work, and the general result of independent studies conducted by Professor Taylor have been described so fully in various technical papers and reports elsewhere listed, that a very brief statement of points of difference between the Michigan and Wisconsin works appears to be all that is necessary here.

Professor Taylor associated with him for consultation Professor Cooley, of Michigan, made a careful study of methods used in earlier appraisals, used the Michigan blank forms as a basis for the preparation of his own, and thoroughly outlined his general plan and the scope of the information desired before actually organizing his staff or commencing work.

In connection with the earlier stages of the work, conferences were held with the officials of the principal railways of the State, and developed a thorough understanding and plans for co-operation between the appraiser and the roads. As a result of these conferences, each large railway company of the State, acting through its heads of departments, made an inventory and appraisal of its own property in the State, using therefor the forms and blanks prepared by the appraiser. At the same time, the appraiser organized a considerably smaller force than was used in Michigan, made his own office and field inspection, and secured data to complete the appraisal on the small roads, in which their own engineering or operating departments were not organized so as to do the work according to plan.

The work turned out by the large roads was then checked by this force, the various points in which they were out of harmony were checked and unified, a number of hearings were held, certain portions of the work were checked over by the appraisers' men, sundry changes in quantity and price were made, and finally, when the work was compiled and put in shape for presentation, the appraiser had reason to believe that he had secured a result which was reasonably free from error, and one in which the railroads had co-operated to such an extent that no charge of prejudice or unfairness would lie.

It is noted that the average cost of reproduction and the present value per mile in Wisconsin are higher than in Michigan, which is probably as it should be, as Michigan has a less mileage of high-class main trunk line road than Wisconsin.

In general, the two appraisals were very similar. The determination of unit prices, the placing of depreciation, the apportionment of locomotives, freight, and passenger equipment, and other rolling stock, the use of the Interstate Commerce Commission's construction classification, the application of percentage values for engineering, interest during construction, administration, legal expenses, and contingencies (this latter fixed at 5.5%), all were along lines similar to those developed in Michigan.

The work of the Wisconsin appraisal was carried on at the same time as the second Michigan appraisal. The investigations made by Mr. Van Ranst Pond and the writer, as to the actual sale prices of right of way, fully discussed heretofore, were conducted at the same time as Professor Taylor's work in Wisconsin was being done, and neither party had any knowledge of the work of the other. The prior discussion relative to this phase of the Michigan valuation is practically a revision of a memorandum submitted by the writer to the Attorney-General in January, 1904. The tables are abstracted from much more extensive ones which, supported by the evidence of Registers of Deeds of some ten counties of Michigan, are part of the record of evidence in Michigan Central Railroad *vs.* Powers. It is, therefore, not only of great interest, but great value, as supporting Professor Cooley's right-of-way valuations, to note the following extract* from Professor Taylor's discussion of the paper by Mr. R. A. Thompson on the Texas railroad valuations:

"In the Wisconsin appraisal, the method followed for valuing the right of way and terminal lands was about as given below. Parts of the right of way of some of the larger systems are estimated at higher ratios than this, but in such cases the roads themselves fixed the right-of-way value.

"The market value for other purposes of the right of way and terminal lands was judged to be the same as that of contiguous property.

"In farming lands, small towns, and suburban and residence property, the right-of-way value was taken to be 25% of the market value for other purposes.

"In city property, the right-of-way value was taken to be 133% of the market value for other purposes, where the land was owned

---

*[*Transactions*, Am. Soc. C. E., Vol. LII, p. 359.

in strips of 100 ft. width or less, and 110% of the market value for other purposes, where the land was owned in blocks, or in widths greater than 100 ft."

No effort whatever was made in the Wisconsin valuation to determine any non-physical or intangible values, the report covering only cost of reproduction and present value of the physical properties.

The Wisconsin work is noteworthy as the first appraisal in which the hearty co-operation of the railroads was secured from the outset. In Michigan the roads at the inception viewed the work with distrust, but by the completion were in hearty sympathy with the efforts of the appraiser to use just and honorable methods, and the managements extended every courtesy in the way of access to records for verification purposes.

The Minnesota State Railway Appraisal.

The valuation of railway properties in the State of Minnesota was undertaken with a view to establishing a basis for rate making. The work was in charge of Mr. Dwight C. Morgan, Engineer of the Railroad and Warehouse Commission of the State, whose full and complete report is a very valuable addition to the literature of valuation practice. This work was undertaken after the completion of that in Michigan and Wisconsin, and advantage was taken of the experiences of the appraisers in these two States. The Wisconsin plan of co-operation with the railroads was adopted, and each company scheduled and appraised its own lines.

The "cost of reproduction," and "present value of physical properties" were the two sets of figures shown in the final results.

Unit prices were fixed on the basis of current prices in 1905, in preference to an average of 5 or 10 years.

Apportionment of locomotives and rolling stock was made on an engine- and car-mileage basis. The organization of an office force was undertaken, and special study was made of the subjects of unit prices and the various local conditions surrounding the different properties, checking of quantities of earthwork, rails, etc., and preparing to harmonize and unify the estimates as they should be received from the railroads.

The greatest difference between this work and that in the other States was the fact that the field inspection, instead of being made by many men, was made by Appraiser Morgan, accompanied by two assistants, inspection being made in a special train, which was paid for by the State.

The detailed reports of the railroad companies were completed and in the hands of the appraiser, maps and profiles of the road were prepared and available, the train was run at slow speed, and many stops were made for examination of bridges, culverts, and structures. About 100 miles per day were covered, but this did not include the larger terminals of St. Paul, Minneapolis, and Duluth, which were given many days.

In the preparation of final summaries, percentage values were placed as follows:

Engineering, superintendence, and legal....	4½	per cent.
Contingencies............................	5	" "
Interest, time of construction varying according to mileage from 1 to 8 years......	4	" "

In addition to these three items, the item of "adaptation and solidification of roadbed" was given a large place, being, for all the roads of the State, $11 713 007.15. This feature was novel to this class of valuation, and it is to be regretted that, in his report, the appraiser did not narrate more fully the detailed methods by which he arrived at his resultant figure.

Land Valuation.—The vexed question of a proper value to give to lands owned by a railway company, was treated by Appraiser Morgan in a different way than it had been in Wisconsin or Michigan. A number of special agents were appointed, who made an exhaustive study of the transfers and assessed values throughout the State. The discussion of this subject in Mr. Morgan's report is exhaustive, and of great interest. The conclusions are quoted. It is regretted that the discussion of methods of valuation can only be given in brief form.

"Careful and full consideration of all information made available for establishing the value of the right of way owned and used by the railway companies for railway purposes, led to the conclusion that in the state at large exclusive of the three terminals of St. Paul, Minneapolis and Duluth, a multiple of three (3) applied to the true value or normal value of lands, as obtained from the transfers, would in general satisfy the conditions.

"During the period referred to, the railway companies paid for the property acquired by them, over and above its normal value, an amount sufficient to justify the use of the following multiples: St. Paul, one and three-fourths (1¾); Minneapolis, one and three-fifths (1⅗), and Duluth, one and one-fourth (1¼), which when applied to the normal value of the lands as established from contiguous and surrounding property, formed the basis for measuring the cost of reproducing the existing terminals of the railway companies."

In the final compilation of results, two sets of schedules were rendered:

(*a*) Those which gave the land values with added increment,
(*b*) Those which omitted the increment.

The cost of the engineering work was about $70 000; this covered 7 596.4 miles of main track, 427.4 miles of second track, and 2 414 miles of side-track, or a total of 10 437.8 miles of all tracks. As yet there has been no decision by the Courts on the Minnesota rate cases.

Forms Used in the Compilation of Information.—The forms used in the Michigan appraisal have been described and fully illustrated. They were all printed on 8½ by 11-in. sheets.

The Wisconsin appraisal used the Michigan forms as a basis, twenty of them being practically identical with the corresponding Michigan forms. The forms shown by Figs. 11 to 21 are materially different from those used in Michigan.

The forms used in Minnesota in 1906 were based on those of Michigan and Wisconsin, and were printed on 14 by 18½-in. sheets. They were remodeled and elaborated to such an extent, however, that the writer believes himself justified in submitting reproductions of the entire set, as representing the most complete form for inventory yet used on any of the State appraisals.

The appraiser in Nebraska in 1909, and Mr. Hansel in New Jersey in 1910, have both returned to the 8½ by 11-in. sheets, and, while both clearly followed earlier precedent in general, both have modified the details to suit the requirements in their respective States.

The Washington State Appraisal.

The State of Washington, through its Railroad Commissioners, made an appraisal of railroad properties within its borders, the work being under the direction of Halbert P. Gillette, M. Am. Soc. C. E.

From Mr. Gillette's report,[*] supplemented by information furnished by Henry L. Gray, Assoc. M. Am. Soc. C. E., Engineer of the

---

[*] *Engineering-Contracting.*

W.B.A. Form 1

WISCONSIN RAILROAD APPRAISAL OF 190 ___

ROADBED REPORT

PART I

Name of Road ______

Between ______ and ______

Office Inspector

Field Inspector

Date ______ 190 ___

LOCATION	ACRES	TOTAL EXCAVATION AND EMBANKMENT			TIES			BALLAST		RAILS		
	Clearing and Grubbing	Earth, cu. yds.	Loose Rock, cu. yds.	Solid Rock, cu. yds.	Number	Kind	Condition	Kind and Amount	Condition	Length of Single Track in ft.	Weight	Condition

W.B.A. Form 2

WISCONSIN RAILROAD APPRAISAL OF 190 ___

ROADBED REPORT

PART II

Name of Road ______

Between ______ and ______

Office Inspector

Field Inspector

Date ______ 190 ___

LOCATION	TIE PLATES AND BRACES			FASTENINGS			FROGS AND SWITCHES			[illegible]		
	Number	Kind	Condition	Number	Weight per foot	Condition	Number	Kind	Condition	Number	Rail Weight	Condition

W.B.A. Form 6

WISCONSIN RAILROAD APPRAISAL OF 190 ___

SIGNAL APPARATUS

Name of Road ______

Between ______ and ______

Office Inspector

Field Inspector

Date ______ 190 ___

LOCATION	NAME AND DESCRIPTION	No. Miles Single Line	Cost New	Condition Per Cent

W.B.A. Form 8

WISCONSIN RAILROAD APPRAISAL OF 190 ___

MISCELLANEOUS ROADWAY ITEMS

Name of Road ______

Between ______ and ______

Office Inspector

Field Inspector

Date ______ 190 ___

LOCATION	Sets Section Tools, Hand Cars, etc.	Condition Per Cent	CROSSING PROTECTION		
			Kind	Amount	Condition Per Cent

FIG. 11.

W.B.A. Form 9

WISCONSIN RAILROAD APPRAISAL OF 190____

Name of Road________________

Between ________ and ________

TELEGRAPH, INSTRUMENTS AND STATION EQUIPMENT

________________ *Office Inspector*

________________ *Feild Inspector*

Date ________ 190 ____

	OWNER	LINE BETWEEN	KEYS	SOUNDERS	RELAYS			Repeaters	Cut Outs		SWITCH BOARDS		Number of Battery Cells	Make of Battery	Length Telegraph or Telephone Lines	Condition Per Cent	
					Western Union	Box	Key on base				Number of Straps	Number of Boards					

W.B.A. Form 38

WISCONSIN RAILROAD APPRAISAL OF 190____

Name of Road________________

Between ________ and ________

FENCES, CATTLE GUARDS AND HIGHWAY CROSSINGS

________________ *Office Inspector*

________________ *Feild Inspector*

Date ________ 190 ____

	LOCATION	Wire or Wooden Fence	Length of Fence (Single Line)	No. Posts Per Mile	Size of Posts	No. Plank or Wire Per Mile	Size of Plank or Wire	Condition Per Cent	Kind of Cattle Guard	Condition Per Cent	Ft. B.M. Crossing Plank	Condition Per Cent

W.B.A. Form 42

WISCONSIN RAILROAD APPRAISAL OF 190____

Name of Road________________

Between ________ and ________

TIMBER TRESTLES AND OPENINGS

________________ *Office Inspector*

________________ *Feild Inspector*

Date________ 190 ____

	LOCATION	DESCRIPTION Total Length; Pile or Frame; Number Stringers; B.M. Framing; Per Lin. Ft., Etc.	Average Height Top Ground To Base Rail	No. Piles Per Bent	Average Penetration of Piles	Condition Per Cent	

Form 21

MINNESOTA RAILROAD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

DOCKS AND WHARVES

With or Without Coal or Ore Handling Equipment

Name of Operating Company ____________
Section Number ____ *From* ________ *To* ________

________ *Field Inspector*
________ *Office Compiler*

DOCKS AND WHARVES												SUPERSTRUCTURE FOR HANDLING COAL OR ORE							COMPLETE PLANT	
LOCATION	Item	Dimensions	Piles Lineal Feet	Framing B.M.Feet	Platform B.M.Feet	Masonry Cubic Yards	Concrete Cubic Yards	Filling Cubic Yards		Age	Condition Per Cent	Type	Dimensions	Timber B.M.Feet	Number of Pockets	Capacity of Pockets	Number of Hoists	Age	Cost of Reproduction	Average Condition Per Cent
								Earth	Stone											

Form 22

MINNESOTA RAILROAD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

INTERLOCKING PLANTS

Name of Operating Company ____________
Section Number ____ *From* ________ *To* ________

________ *Field Inspector*
________ *Office Compiler*

LOCATION	Name of Railway Crossed	When Built	TOWER HOUSE			Kind of Machine	NUMBER OF LEVERS			KIND OF CONNECTION PIPE OR WIRE TO			Foundations, Wood or Concrete	SIGNAL POSTS		NUMBER OF FUNCTIONS OPERATED			ELECTRIC CIRCUIT FOR			Average Condition Per Cent	Per Cent of Construction Cost Paid By This Company	Per Cent of Maintenance Cost Paid By This Company	Per Cent Operating Cost Paid By This Company	Cost of Reproduction
			Kind	Dimensions	Cond. Per Ct.		Work	Spare	Total	Derails	Switches	Signals		High	Dwarf	Derails	Switches	Signals	Locks	Indicators	Bells					

Form 23

MINNESOTA RAILROAD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

SIGNAL APPARATUS

Name of Operating Company ____________
Section Number ____ *From* ________ *To* ________

________ *Field Inspector*
________ *Office Compiler*

LOCATION	TRAIN ORDER AND MANUAL BLOCK SIGNALS OPERATED IN CONJUNCTION WITH THE TELEGRAPH					AUTOMATIC BLOCK SIGNALS							DISTANT SWITCH SIGNALS			ELECTRIC BELLS FOR HIGHWAY CROSSING PROTECTION				
	Type of Signal	Manufactured by	Number Installed	Condition Per Cent	Miles of Single Line Protected	Type of Signal	Manufactured by	Number Installed	Number Switch Indicators	Circuit Lines or Wire	Miles of Single Line Protected	Condition Per Cent	Type of Signal	Number Installed	Condition Per Cent	Location	Manufactured by	Number Installed	Circuit Lines or Wire	Condition Per Cent

Form 24

MINNESOTA RAILROAD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

TELEGRAPH, TELEPHONE LINES & APPURTENANCES

In Case Lines are not Owned, Only Show Such Equipment as Actually Belongs to the Railroad Company

Name of Operating Company ____________
Section Number ____ *From* ________ *To* ________

________ *Field Inspector*
________ *Office Compiler*

LOCATION	OWNER	GENERAL DESCRIPTION													REMARKS
		Number of Miles	Number of Poles per Mile	Number of Wires Strung	Kind of Wire	Number of Keys	Number of Sounders	Number of Relays	Number and Capacity of Switch Boards	Number of Telephone Transmitters and Receivers	Kind of Battery	Number of Cells	Cost of Reproduction	Condition Per Cent	

FIG. 13.

Form 25

MINNESOTA RAILROAD & WAREHOUSE COMMISSION

RAILROAD APPRAISAL OF 1906

LOCOMOTIVES

Name of Operating Company ____________

Locomotive in Service in Minnesota ______ Total Number

____________ *Field Inspector*

____________ *Office Compiler*

ENGINES																	TENDER				
Name of Builder	Engine Number	Class	Simple or Compound	Service	Dimensions of Cylinders	Diam. of Boiler	Working Pressure	Driving Wheels		Weight on Driving Wheels	Weight on Trailing Wheels	Weight on Truck	Hauling Capacity	Brake Equipment	When Built	When Given General Repairs	Water Capacity	Coal Capacity	Total Weight Engine & Tender Loaded	Cost of Reproduction	Condition Per Cent
								No.	Diam.												

Form 26

MINNESOTA RAILROAD & WAREHOUSE COMMISSION

RAILROAD APPRAISAL OF 1906

PASSENGER EQUIPMENT

Name of Operating Company ____________

Passenger Equipment on System ____________ Cars

Passenger Equipment Assigned to Minnesota ____________ Cars

Passenger Car Mileage System ______ Miles

Passenger Car Mileage, Minnesota ______ Miles

____________ *Field Inspector*

____________ *Office Compiler*

Serial Number	Kind of Equipment	Class	Dimensions	Design of Vestibule	Kind of Coupler	Number of Seats	Kind of Heat	Kind of Light	Trucks Number of Wheels	Brake Equipment	Name of Builder	When Built	Total Number of Cars Now in Service	Cost of Reproduction	Condition Per Cent	Give Number of Cars Each Series Assigned to Minnesota

Form 27

MINNESOTA RAILROAD & WAREHOUSE COMMISSION

RAILROAD APPRAISAL OF 1906

FREIGHT CAR EQUIPMENT

Include Cabooses in this Statement.

Name of Operating Company ____________

Freight Car Mileage, System ______ Miles

Freight Car Mileage, Minnesota ______ Miles

____________ *Field Inspector*

____________ *Office Compiler*

Serial Numbers	Class of Equipment	Sills and Body Steel or Wood	Dimensions	Capacity	Kind of Couplers	Size of Journals	Brake Equipment	Name of Builder	When Built	Number of Cars Now in Service	Cost of Reproduction	Condition Per Cent	REMARKS

Form 28

MINNESOTA RAILROAD & WAREHOUSE COMMISSION

RAILROAD APPRAISAL OF 1906

MISCELLANEOUS EQUIPMENT

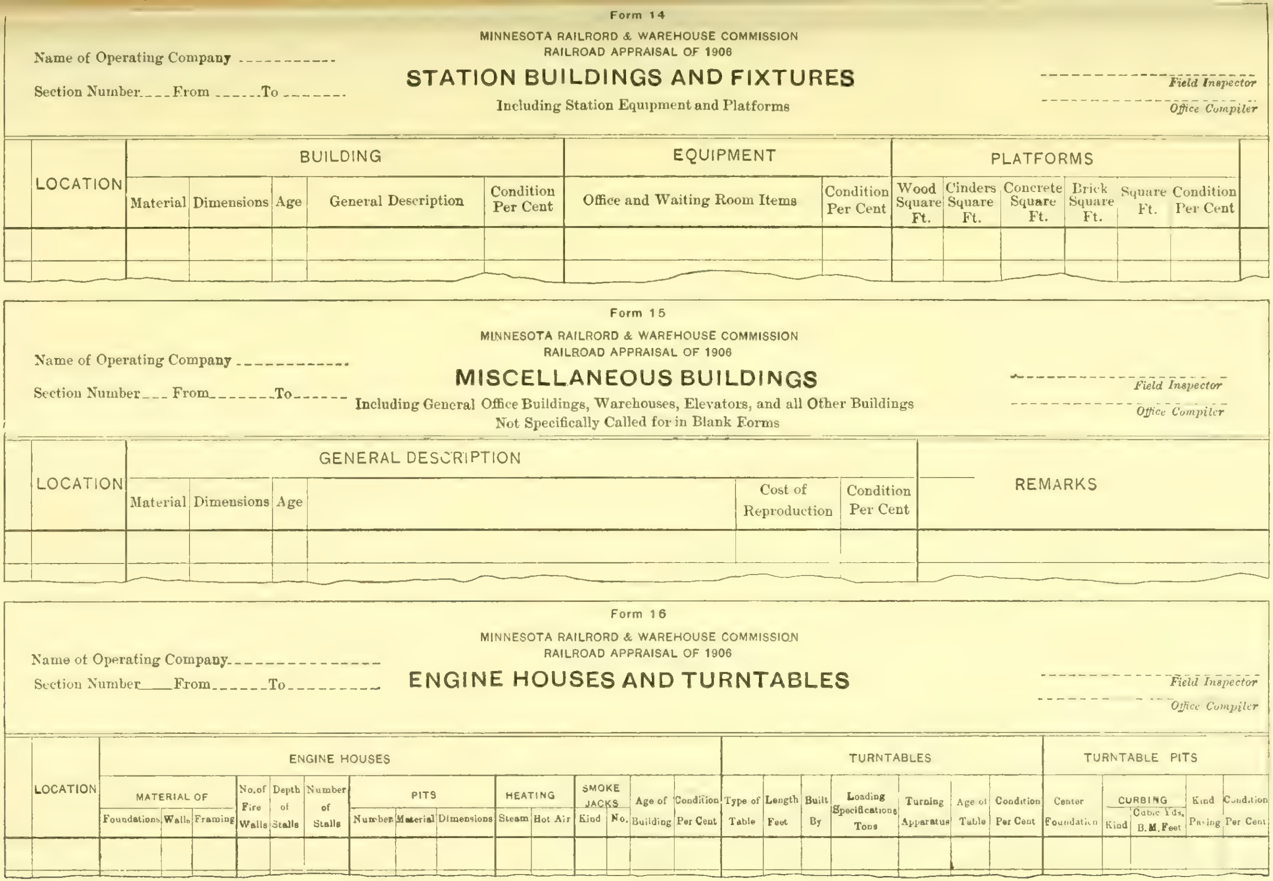
Include Snow Plows, Flangers, Steam Shovels, Pile Drivers, Derrick Cars, Dredges, and all Special Equipment, Located or used in Minnesota.

Name of Operating Company ____________

____________ *Field Inspector*

____________ *Office Compiler*

LOCATION	DESCRIPTION	Name of Builder	Age	Cost of Reproduction	Condition Per Cent



Form 14

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

Name of Operating Company -----------

Section Number---From -----To ------

STATION BUILDINGS AND FIXTURES

Including Station Equipment and Platforms

---------------------- *Field Inspector*

---------------------- *Office Compiler*

	LOCATION	BUILDING					EQUIPMENT		PLATFORMS						
		Material	Dimensions	Age	General Description	Condition Per Cent	Office and Waiting Room Items	Condition Per Cent	Wood Square Ft.	Cinders Square Ft.	Concrete Square Ft.	Brick Square Ft.	Square Ft.	Condition Per Cent	

Form 15

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

Name of Operating Company ------------

Section Number--- From-------To------

MISCELLANEOUS BUILDINGS

Including General Office Buildings, Warehouses, Elevators, and all Other Buildings
Not Specifically Called for in Blank Forms

---------------------- *Field Inspector*

---------------------- *Office Compiler*

	LOCATION	GENERAL DESCRIPTION						REMARKS
		Material	Dimensions	Age		Cost of Reproduction	Condition Per Cent	

Form 16

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

Name of Operating Company----------------

Section Number____From------To---------

ENGINE HOUSES AND TURNTABLES

---------------------- *Field Inspector*

---------------------- *Office Compiler*

	LOCATION	ENGINE HOUSES															TURNTABLES							TURNTABLE PITS				
		MATERIAL OF			No. of Fire Walls	Depth of Stalls	Number of Stalls	PITS			HEATING		SMOKE JACKS		Age of Building	Condition Per Cent	Type of Table	Length Feet	Built By	Loading Specifications Tons	Turning Apparatus	Age of Table	Condition Per Cent	Center Foundation	CURBING		Kind Paving	Condition Per Cent
		Foundations	Walls	Framing				Number	Material	Dimensions	Steam	Hot Air	Kind	No.											Kind	Cubic Yds. B. M. Feet		

FIG. 15.

Form 17

MINNESOTA RAILROAD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

CINDER PITS AND TRACK SCALES

Name of Operating Company__________

Section Number____From________To________

__________ *Field Inspector*

__________ *Office Compiler*

	CINDER PITS AND HOISTS					TRACK SCALES						
LOCATION	Material of Pit	Dimensions	Age	Pneumatic or Power Hoists. General Description	Condition Per Cent	LOCATION	Name of Manufacturer	Material of Foundation	Dimensions	Capacity Tons	Condition Per Cent	REMARKS

Form 10

MINNESOTA RAILROAD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

FENCES CATTLE GUARDS AND SIGNS

Name of Operating Company__________

Section Number From________To________

Length of Main Line Roadway______Miles______

__________ *Field Inspector*

__________ *Office Compiler*

	RIGHT OF WAY FENCES								SNOW FENCES				CATTLE GUARDS						HIGHWAY CROSSINGS			MISCELLANEOUS ROADWAY SIGHTS		
	WOOD FENCE				WIRE FENCE				TEMPORARY & PERMANENT				WOOD			IRON			PLANKING USED					
LOCATION	No. Boards Per Panel	No. Posts Per Mile	No. Miles Sngl. Line	Condition Per Cent	No. Wires Per Panel	No. Posts Per Mile	No. Miles Sngl. Line	Condition Per Cent	Length Per Panel	B. M. Ft. Per Panel	Total Length in Lineal Feet	Condition Per Cent	Kind	Number	Condition Per Cent	Kind	Number	Condition Per Cent	Number of Crossing	Total B. M. Ft. Used	Condition Per Cent	Kind	Number	Condition Per Cent
																						Mile Posts		
																						Whistling Posts		

Form 1

MINNESOTA RAILROAD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

LANDS FOR RIGHT OF WAY, YARDS AND TERMINALS

Separate by Counties, and for Incorporated Cities, Villages and Towns
Show Joint Right of Way Separately and Indicate Division of Ownership

Name of Operating Company__________

Section Number____From____To____

Length of Main Line Roadway______Miles______

__________ *Field Inspector*

__________ *Office Compiler*

			WIDTH OF RIGHT OF WAY								LANDS FOR YARD AND TERMINALS				
LOCATION	Name of County	Name of Incorporated City, Village, or Town	FEET Miles	FEET Miles	FEET Miles	FEET Miles	FEET Miles	Total Acres Right of Way	Average Market Value Per Acre	Average Right of Way Value Per Acre	LOCATION	Total Acres	Average Market Value Per Acre	Average Value for Railway Purposes Per Acre	REMARKS

Name of Operating Company ____________

Section Number______ From______ To______

MINNESOTA RAILROAD & WAREHOUSE COMMISSION

RAILROAD APPRAISAL OF 1906

STEAM & ELECTRIC POWER PLANTS—GAS PLANTS

Include all Shafting, Belting, Motors, Etc., Operated from Central Plant

______________ *Field Inspector*

______________ *Office Compiler*

			GENERAL DESCRIPTION								
	LOCATION	Kind of Plant	POWER BUILDING					POWER EQUIPMENT	Cost of Production	Condition Per Cent	
			Material	Dimensions	Age	Cost of Production	Condition Per Cent				

Form 19

Name of Operating Company ____________

Section Number______ From______ To______

MINNESOTA RAILROAD & WAREHOUSE COMMISSION

RAILROAD APPRAISAL OF 1906

GENERAL REPAIR SHOPS

______________ *Field Inspector*

______________ *Office Compiler*

		MOTIVE POWER AND REPAIR SHOP								
	LOCATION	Dimensions	MATERIAL USED FOR			Age Years	General Description and Purposes for Which Each Building is Used	Cost of Reproduction	Condition Per Cent	
			Foundations	Walls	Frame					

Form 20

Name of Operating Company ____________

Section Number______ From______ To______

Located at ____________

MINNESOTA RAILROAD & WAREHOUSE COMMISSION

RAILROAD APPRAISAL OF 1906

SHOP MACHINERY AND TOOLS

Separate by Buildings in Which They are Located

Shafting, Belting, Motors, Etc., to be Included on Form No. 18 Power Plants

______________ *Field Inspector*

______________ *Office Compiler*

	MACHINES WITH ACCOMPANYING TOOLS					MACHINES WITH ACCOMPANYING TOOLS					MACHINES WITH ACCOMPANYING TOOLS					REMARKS
	Name of Machine	Name of Maker	Age	Cost of Reproduction	Condition Per Cent	Name of Machine	Name of Maker	Age	Cost of Reproduction	Condition Per Cent	Name of Machine	Name of Maker	Age	Cost of Reproduction	Condition Per Cent	

FIG. 17.

Form 7

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

PILE BRIDGES AND TIMBER TRESTLES

Include Timber Overhead Highway Bridges Erected at
Expense of Railway Company

Name of Operating Company__________

Section Number_____From________To______

__________ *Feild Inspector*

__________ *Office Compiler*

	LOCATION	GENERAL DESCRIPTION				PILES			CAPS			FRAMED BENTS			SUPERSTRUCTURE FOR PILE OR FRAMED BENTS									Structure Average Condition Per Cent	
															STRINGERS			TIES			GUARD RAILS				
		Bridge Number	Total Length	Average Height	Number of Bents	Kind of Timber	Number of Piles Per Bent	Total Lineal Feet Pilling	Kind of Timber	Dimensions	Number of Caps	Kind of Timber	Dimensions	B.M. Feet Including Sills and Caps	Kind of Timber	Dimensions	No. per Span	Kind of Timber	Dimensions	Number of Ties	Kind of Timber	Dimensions	Lineal Feet		

Form 8

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

CULVERTS

Include all Arch, Box, Cast Iron or Vitrified Pipe Culverts
Stone, Concrete, or Wood

Name of Operating Company__________

Section Number __ From ________To ______

__________ *Feild Inspector*

__________ *Office Compiler*

	LOCATION	Culvert Number	Design	Material	Dimensions	MASONRY		Concrete Cubic Yards	PAVING		Timber B.M. Feet	Age	Condition Per Cent	REMARKS
						Class	Cubic Yards		Material	Cubic Yards				

Form 9

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

TRACK AND BRIDGE TOOLS

Name of Operating Company__________

Section Number_____From________To ______

__________ *Feild Inspector*

__________ *Office Compiler*

	LOCATION	TRACK TOOLS ASSIGNEC TO SECTIONS					BRIDGE TOOLS ASSIGNED REGULAR CREWS					NOTE:- In Space Below, List Kind and Number of Tools in use by Average Section and Bridge Crew, Covering General Track and Bridge Work
		Number of Section	HAND CARS		TOOLS		LOCATION	HAND CARS		TOOLS		
			Number	Condition Per Cent	Number of Sets	Condition Per Cent		Number	Condition Per Cent	Number of Sets	Condition Per Cent	

Form 11

Name of Operating Company ____________ MINNESOTA RAILROAD & WAREHOUSE COMMISSION ____________ *Field Inspector*

Section Number ____ From ____ To ____ RAILROAD APPRAISAL OF 1906 ____________ *Office Compiler*

STOCK YARDS AND APPURTENANCES

		YARDS								WATER SUPPLY AND POWER								STOCK SCALES				
								PAVING		WELLS				WIND MILLS								
	LOCATION	Number of Pens	Dimensions	Number of Gates	Sheds and Dimensions	Age	Condition Per Cent	Kind	Square Feet	Diameter	Depth	Other Means of Supply and Description	Pumps	Size Wheel	Tower, Kind and Height	Other Power Used, and Description	Cond Per Cent	Kind	Capacity Tons	Dimensions of Platform	Cond. Per Cent	

Form 12

Name of Operating Company ____________ MINNESOTA RAILROAD & WAREHOUSE COMMISSION ____________ *Field Inspector*

Section Number ____ From ____ To ____ RAILROAD APPRAISAL OF 1906 ____________ *Office Compiler*

WATER STATIONS

			PUMP HOUSE				POWER										PUMPS								WATER TANKS				WATER CRANES						
							BOILERS			GAS ENGINES			WIND MILLS							SUCTION PIPE		DISCHARGE PIPE										SUPPLY PIPE			
	LOCATION	Source Supply If Well, Give Diameter and Depth	Material	Dimensions	Age Years	Condition Per Cent	Horizontal Vertical	Dimensions	Cond. Per Ct.	Kind	H.P.	Cond. Per Ct.	Kind	Tower, Kind and Height	Diam. Wheel	Cond. Per Ct.	Kind	Diameter of Cylinder	Condition Per Cent	Diam.	Length	Diam.	Length	Cond. Per Ct.	Diameter	Capacity Gal.	Tower, Kind and Height	Condition Per Cent	Kind	Diam. Column	Condition Per Cent	Diam.	Length	Cond. Per Ct.	

Form 13

Name of Operating Company ____________ MINNESOTA RAILROAD & WAREHOUSE COMMISSION ____________ *Field Inspector*

Section Number ____ From ____ To ____ RAILROAD APPRAISAL OF 1906 ____________ *Office Compiler*

COAL STATIONS

			GENERAL DESCRIPTION OF BUILDING						APPROACH			SPECIAL APPLIANCES FOR HOISTING AND CONVEYING		
	LOCATION	Type Chute or Crane	Kind of Foundation	Dimensions of Building	Number of Pockets	Total Capacity Tons	Age of Building	Condition Per Cent	Design	Length	Condition Per Cent	General Description	Condition Per Cent	

FIG. 19.

Form 1 A

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

RAILWAY TERMINAL PROPERTY

Name of Operating Company ______
Section Number ______ City of ______

______ *Field Inspector*
______ *Office Compiler*

TERMINAL MAP	SECTION NO.	DESCRIPTION OF PROPERTY OWNED	TOTAL ACRES OWNED	Average Market Value Per Acre	Average Right of Way Value Per Acre	TOTAL VALUE

Form 2

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

ROADWAY REPORT

Name of Operating Company ______
Section Number ______ From ______ To ______
Length of Main Line Roadway ______ Miles

In Recording Information, Show Main Tracks Separate from Passing, Side, and Industry Tracks;
Show Joint Tracks Separately, and Indicate Division of Ownership.
The above does not apply to Grading or Protection except for Joint Tracks.

______ *Field Inspector*
______ *Office Compiler*

		GRADING—CUBIC YARDS—PAY QUANTITIES					PROTECTION				CROSS TIES						SWITCH TIES (Including Head Blocks)					
		EXCAVATION			EMBANKMENT			RETAINING WALLS				Oak	Cedar	Hemlock	Other Kinds			Number of Sets				
LOCATION	Acres Clearing and Grubbing	Earth	Loose Rock	Solid Rock	Earth	Loose Rock	Rip Rap Cu. Yds.	Dry Wall Cu. Yds.	Mortar Wall Cu. Yds.	Concrete Wall Cu. Yds.	Dimensions	Number	Number	Number	Number	Cond. Per Cent	B.M. Feet Per Set	Oak	Pine	Hemlock	Other Kinds	Cond. Per Cent

---

Form 3

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

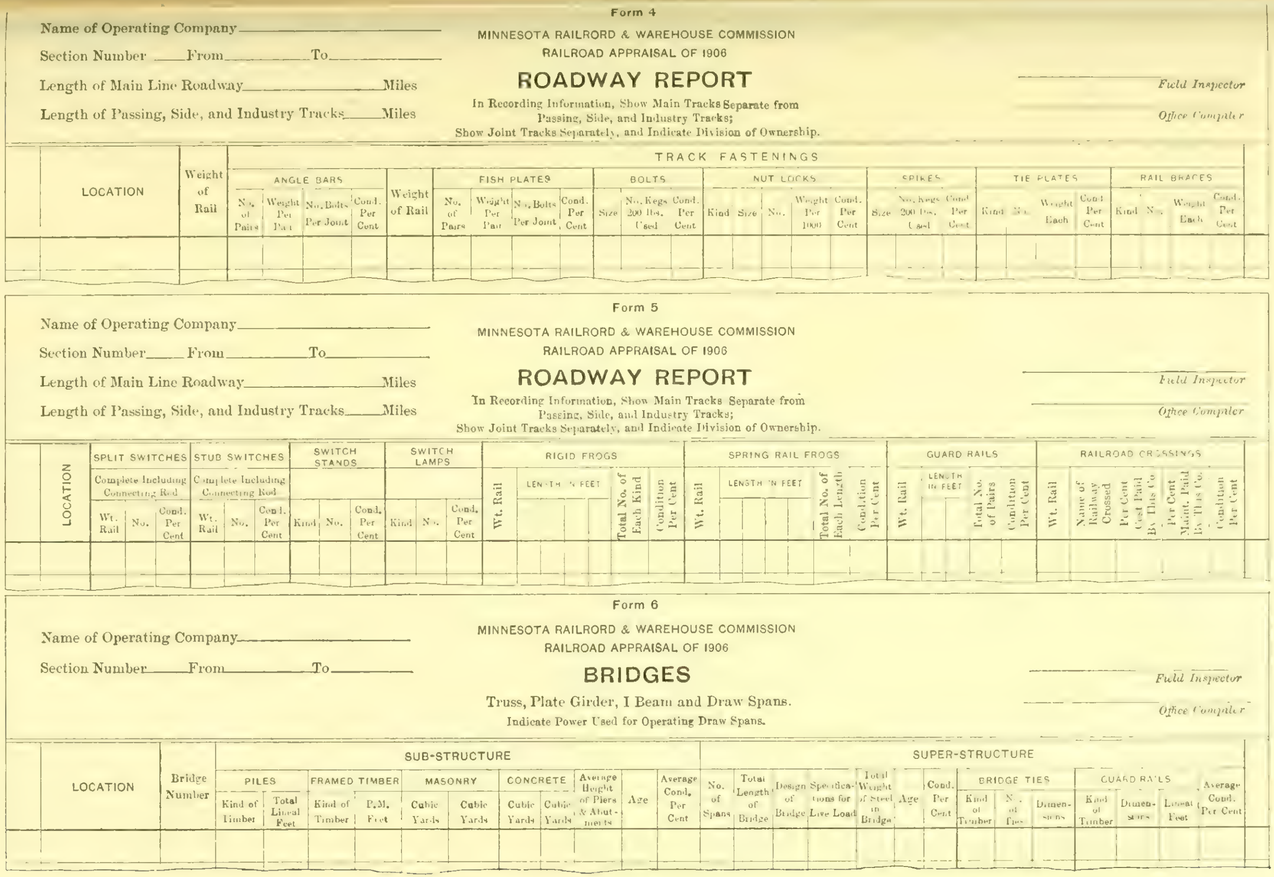
ROADWAY REPORT

Name of Operating Company ______
Section Number ______ From ______ To ______
Length of Main Line Roadway ______ Miles
Length of Passing, Side and Industry Tracks ______ Miles

In Recording Information, Show Main Tracks Separate from
Passing, Side, and Industry Tracks;
Show Joint Tracks Separately, and Indicate Division of Ownership

______ *Field Inspector*
______ *Office Compiler*

BALLAST						RAILS (Insert Weight of Rail per Yard)																	
LOCATION	Miles	Kind of Material	Width at Crown	Average Depth Under Tie	Condition Per Cent	LOCATION	Time in Service Years	New When Laid Miles	Relaying Rails Miles	Wt. Track Miles	Cond. Per Cent	Wt. Track Miles	Cond Per Cent	Wt. Track Miles	Cond. Per Cent	Wt. Track Miles	Cond. Per Cent	Wt. Track Miles	Cond. Per Cent	Wt. Track Miles	Cond. Per Cent	Wt. Track Miles	Cond. Per Cent



Form 4

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

ROADWAY REPORT

In Recording Information, Show Main Tracks Separate from Passing, Side, and Industry Tracks;
Show Joint Tracks Separately, and Indicate Division of Ownership.

Name of Operating Company____________

Section Number ____ From________ To________

Length of Main Line Roadway__________ Miles

Length of Passing, Side, and Industry Tracks____ Miles

__________ *Field Inspector*

__________ *Office Compiler*

LOCATION	Weight of Rail	TRACK FASTENINGS																											
		ANGLE BARS				Weight of Rail	FISH PLATES				BOLTS			NUT LOCKS					SPIKES			TIE PLATES				RAIL BRACES			
		No. of Pairs	Weight Per Pair	No. Bolts Per Joint	Cond. Per Cent		No. of Pairs	Weight Per Pair	No. Bolts Per Joint	Cond. Per Cent	Size	No. Kegs 200 lbs. Used	Cond. Per Cent	Kind	Size	No.	Weight Per 1000	Cond. Per Cent	Size	No. Kegs 200 lbs. Used	Cond. Per Cent	Kind	No.	Weight Each	Cond. Per Cent	Kind	No.	Weight Each	Cond. Per Cent

Form 5

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

ROADWAY REPORT

In Recording Information, Show Main Tracks Separate from Passing, Side, and Industry Tracks;
Show Joint Tracks Separately, and Indicate Division of Ownership.

Name of Operating Company____________

Section Number____ From________ To________

Length of Main Line Roadway__________ Miles

Length of Passing, Side, and Industry Tracks____ Miles

__________ *Field Inspector*

__________ *Office Compiler*

LOCATION	SPLIT SWITCHES			STUB SWITCHES			SWITCH STANDS			SWITCH LAMPS			RIGID FROGS						SPRING RAIL FROGS							GUARD RAILS					RAILROAD CROSSINGS				
	Complete Including Connecting Rod			Complete Including Connecting Rod									Wt. Rail	LENGTH IN FEET			Total No. of Each Kind	Condition Per Cent	Wt. Rail	LENGTH IN FEET				Total No. of Each Length	Condition Per Cent	Wt. Rail	LENGTH IN FEET		Total No. of Pairs	Condition Per Cent	Wt. Rail	Name of Railway Crossed	Per Cent Cost Paid By This Co.	Per Cent Maint. Paid By This Co.	Condition Per Cent
	Wt. Rail	No.	Cond. Per Cent	Wt. Rail	No.	Cond. Per Cent	Kind	No.	Cond. Per Cent	Kind	No.	Cond. Per Cent																							

Form 6

MINNESOTA RAILRORD & WAREHOUSE COMMISSION
RAILROAD APPRAISAL OF 1906

BRIDGES

Truss, Plate Girder, I Beam and Draw Spans.
Indicate Power Used for Operating Draw Spans.

Name of Operating Company____________

Section Number____ From________ To________

__________ *Field Inspector*

__________ *Office Compiler*

LOCATION	Bridge Number	SUB-STRUCTURE											SUPER-STRUCTURE													
		PILES		FRAMED TIMBER		MASONRY		CONCRETE		Average Height of Piers & Abutments	Age	Average Cond. Per Cent	No. of Spans	Total Length of Bridge	Design of Bridge	Specifications for Live Load	Total Weight of Steel in Bridge	Age	Cond. Per Cent	BRIDGE TIES			GUARD RAILS			Average Cond. Per Cent
		Kind of Timber	Total Lineal Feet	Kind of Timber	B.M. Feet	Cubic Yards	Cubic Yards	Cubic Yards	Cubic Yards											Kind of Timber	No. of Ties	Dimensions	Kind of Timber	Dimensions	Lineal Feet	

Fig. 21.

Railroad Commission of Washington, the following general statement as to methods is gleaned:

The plan involved, not only a determination of cost of reproduction and present value, but also original cost.

The appraiser was unable to adopt the methods followed in Wisconsin and Minnesota, in so far as they accepted the inventory of the railroads, but made his own examinations of records. The railroads of the State denied that they had any information whatever that would be of value to the Commission.

The records of the Engineering Department were examined. The records of the Accounting Department were analyzed, various annual reports were examined and a corporate history of the road prepared.

Special forms for securing information were not prepared, and no rules, or definite order of procedure to be used for all roads alike, were adopted.

It is somewhat difficult to determine from the appraiser's report just what part of it covers actual work done, and what part is theory developed from the work, but presumably maps were prepared and profiles secured which represented the original conditions of construction.

The field inspection was made on hand-cars or on foot, each field inspector being furnished with the plans, profiles, etc.

The same conditions existed in Washington as elsewhere, that is, certain records were not kept up, and were found to be inaccurate and unreliable, and, as a result, the appraiser reported the condition to be such as "to cause much unnecessary work subsequently in checking."

A percentage of depreciation was not placed in the field, but was determined by "mortality tables," or by ascertaining the probable years of structure life, then determining from the age of the particular structure under consideration its percentage of depreciation, a method by no means new. It is not stated that any attempt was made to compare these tables with the rules of the Master Car Builders Association for valuing equipment, and no field inspection of equipment was made. The prevailing prices of materials formed the basis for estimating the cost of reproduction.

The value of motive power and rolling stock was apportioned among the States on the basis of engine- and car-mileage.

The land values were fixed by the Railroad Commission sitting as a court, real estate men from the large cities, real estate experts brought by the railway companies, and others testified; and based on this testimony, the value was determined by the Commission in the same manner as in a condemnation case. Three right-of-way experts, all of whom had had experience in purchasing right of way for roads, were in the regular employ of the Commission, and details as to present values were referred to them.

The chief point of difference between this work and that of the other States apparently was the effort to ascertain first cost of the properties plus additions. This was done by an examination of the accounts of the railway companies.

The result of the Washington work, as far as rate making is concerned, is indeterminate, as the United States Courts have held that the Commission may not fix freight rates. The Supreme Court of the State has held that they could. The Supreme Court has also held that the Tax Commission should accept the findings of the Railroad Commission for the purpose of taxation, with the result, as stated by Mr. Gray, that more than $1 250 000 more was received last year than during any prior year from railroad taxes.

The report of the Washington appraiser differs widely from that for other States in that it is diffuse and does not present the methods clearly and systematically; it is difficult, indeed, to trace what was actually done. The writer is loath to criticize, but this report is such as to suggest comment on a number of points.

1.—Throughout the report very great stress is laid on the cost of making the appraisal. Such an undertaking as an appraisal of corporation property should be done thoroughly or left alone. It matters not whether the work of Professor Cooley or Professor Taylor cost $5 a mile or $50 a mile, if a dependable result was secured. It does not appear to be good taste either to criticize costs of work in other States, or compare the costs in Wisconsin and Michigan with the costs in Washington.

2.—A number of criticisms, amounting almost to reflections, are made on the methods elsewhere. The appraiser says:

"Speaking for myself, I found the precedents established by Texas, Michigan, and Wisconsin of little value either in deciding the methods to be pursued in making the appraisals or in estimating the probable cost of appraisal. * * *

"In estimating present or depreciated values of structures, rolling stock, etc., both Michigan and Wisconsin had sent experts into the field to estimate the percentage of present value to each unit. In this manner 40 000 freight cars were inspected in Michigan and their "present value" estimated. To me this seemed to be not only a useless procedure but very erroneous. * * *

"The appraisals heretofore made in other states have been based almost entirely upon field surveys and inspection, no attempt having been made to secure the necessary data from the engineering and accounting records of the railways. Why? The answer is found in the purpose of the appraisal."

Such sentences, and others which, by inference if not by name, reflect on work executed by men of high professional standing, are hardly in good taste, even if true, in a report to a railroad commission of another State. Whether or not he found little of value, the appraiser's general line of procedure was not radically different from that followed in Michigan and Wisconsin in getting all available data first from the companies, then in making a field inspection before fixing values. If misled by erroneous profiles, he went into an error needlessly, as it was fully known in Michigan that records were in the condition described before any field work was begun.

The inspection of freight cars in Michigan was not to "estimate present value" but to determine at first hand whether the Master Car Builders rules for valuation were safe to use, and to back up their use in Court.

The third paragraph quoted is a misstatement, due clearly to a misapprehension of what really was done.

3.—The spirit of suspicion of railroad men's motives is an unfortunate one to carry into a railroad appraisal, much less into a report.

4.—The writer fully realizes the magnitude of the task before the appraiser who is asked to determine first cost plus improvements or betterments.

Hardly a trunk line road exists to-day that has not grown up from a small beginning, changed its line, reduced its grades, added safety devices, changed the type of its bridges and buildings, increased the weight of its rails, put in service much heavier equipment, in fact, completely changed everything, except, perhaps, the original right of way.

The task of securing from old accounting department records an accurate statement of cost, is, and the writer says it with the confidence born of experience, an impossibility. It is a job of such magnitude as to be practically prohibitive. The different systems of accounting, the different policies of the management, as to charging betterments to capital or operating expense, to say nothing of the countless errors that creep into the distribution of accounts, place such an undertaking among the labors of a modern Hercules, and, to one who has been engaged even in the task of trying to ascertain what one year's accounting on a large road may do in concealing betterments under the guise of operating expense, it would appear that a result that could be sworn to as correct was impossible of attainment along the lines suggested in this report.

The general question of the propriety of the use of mortality tables is discussed elsewhere in this paper.

This document, as an addition to the literature of the subject of valuation of properties, is disappointing, for if there were original and valuable methods they are not explicitly described.

The cost of making the appraisal was about $13 per mile of line.

THE VALUATION OF TRACTION PROPERTIES IN CHICAGO.

During 1906 a complete valuation of the property and franchises of the surface roads of Chicago was made under the direction of a Commission consisting of Bion J. Arnold, M. Am. Soc. C. E., and Messrs. Mortimer E. Cooley, and A. B. du Pont. The report of this valuation was published in the form of a pamphlet which is now practically out of print as all extra copies were long ago exhausted.

The instructions of this Commission from the Chicago City Council were:

"To consider the detailed inventories and estimates of value to be submitted by the Street Railway Companies, to investigate the same and to ascertain whether the values thus listed were reasonable, fair and just."

Detailed inventories and estimates of value were submitted by the roads, and, from time to time during the progress of the work, additions or corrections to these schedules were made.

Reports showing income, operating expense, and traffic statistics were made, and such detailed statements as were called for from time to time were furnished.

The Commission organized its force for valuation work by using the office and field organization of the Arnold Company under the direct charge of George Weston, M. Am. Soc. C. E., for the major part of the work, and retained Messrs. Theodore H. Hinchman, Jr., C. V. Conover, and the writer to give special study to certain features of the appraisal. In the determination of franchise values, Professor Henry C. Adams was retained in consultation by the Commission.

In arriving at the value of the physical properties, a complete field examination was made, depreciation determined, cost of reproduction estimated, and in general, the work was carried on along lines quite similar to those of the railway appraisals heretofore described in detail.

Several very interesting and unique problems were presented, some of which were as follows:

"Upon what basis shall the cable properties of the companies be estimated—(*a*) as operating cable systems, or (*b*) as obsolete systems having no value except so far as the physical property can be utilized in the conversion of the cable lines into electric?"

In the final conclusions of the Commission, part of the cable lines were treated in one way, and part in the other.

"What allowance, if any, shall be made for the pavements laid by the companies on their right of way?"

The discussion of this topic, together with the opinions of counsel as to the legal status, is of interest. The Commission did not consider the value of paving as constituting any part of the physical property, the value of which must be supported out of earnings. The present value of the pavement was estimated and reported without specific recommendation as to whether an allowance should be made.

The valuation of real estate was left in the hands of real estate experts familiar with values in Chicago, each piece of property being personally examined and valued, and the representatives of the roads given such hearings as they desired.

In computing the value of physical properties, an allowance of 10% was made to cover the following items:

"*1.—Legal Expenses*—including those incurred in securing right of way and frontage consents.

"*2.—Interest or carrying charge* for the money expended during the construction period and up to the time the property goes into operation.

"*3.—Brokerage*—or the expense of securing the necessary moneys.

"*4.—Contingencies*—to cover incomplete inventories, unforeseen difficulties of construction, and any and all other items of expense which cannot be foreseen."

The only novel feature in this list is Item 3, which was not included specifically in any of the railroad valuations made by States and heretofore described.

The franchise and intangible property valuation, amounting to some $9 000 000, or about one-fifth of the total, was a very important phase of the work, and the Commission gave up a large part of the report to its discussion.

The difficulties in this part of the work are described as threefold:

"*First.*—The difficulty of determining what are the exact legal rights of the companies in any given street or part of street, in absence of a direct and final judicial decision as to these rights;

"*Second.*—The difficulty in estimating the value of a line of street railways, consisting of several parts, where each of these parts is operated under a different tenure due to the character of the ordinances or franchises, respectively; and

"*Third.*—The difficulties arising from the absence of exact information as to the receipts and expenditures on the several parts of a single line covered by franchises of different length and character."

The Commission, having arrived at such an adjustment of the difficulties as appeared just, determined the value of franchises in the following manner:

It was assumed that the gross earnings on the different parts or routes of each system were in proportion to the car-mileage.

The system was divided into routes, and the car-mileage was determined for each route; then this information was compiled so as to show the car-mileage, and consequently the gross earnings, apportionable to each franchise.

The next step was to determine, in the same manner, the proportion of operating expenses assignable to each franchise, the operating expense being assumed to be uniform with gross earnings. A study of the conditions in Chicago resulted in a determination upon 70% as a fair proportion for operating expenses, taxes, and maintenence.

Next, the amount of capital investment to be supported out of earnings was computed by estimating the cost of reproduction of track and overhead lines under each franchise and apportioning the cost of land, power-houses, barns, cars, tools, and stores in proportion to car-mileage.

In determining earnings for the unexpired years of franchise life, it was assumed that the earnings would increase in accordance with the law laid down by Mr. Arnold in 1902.

The last step was to find the value of the net earnings of future years, after deducting the sum required to support the invested capital. The rate chosen was 5% compound interest. The sum of the different present values thus found was the value of the franchise sought.

Two other points arising in connection with franchise values were:

> "Where, on a street, franchises covering part of the street have expired, and others remain in force, the contention of the city is that the expired franchise is valueless because traffic under it can be stopped; that of the company is that it still has value, as traffic can be routed over other streets where franchises have not expired."

This was set aside on the ground that the value of any particular portion of a street, or of a franchise, remains the same as long as the system is considered as an entirety.

The second point was as to the value of traffic agreements; but this complicated problem was also dismissed on the theory that when two systems are considered as co-operating, the value of individual parts of either system remains the same regardless of their ownership.

The values of their properties, fixed by the companies, included paving. The total figures reached in this valuation were:

Companies'	valuation,	including	paving,	$73 555 675
Commission's	"	"	"	50 994 782
Commission's	"	excluding	"	46 652 747

This work affords many interesting problems, and is perhaps the largest valuation for determining a price for the purchase of property that had been made to date.

The Commercial Valuation of Railway Operating Property of the Department of Commerce and Labor.

In 1902 the permanent Census Office was established, and the Director was authorized to collect statistics relative to public indebtedness, valuation, taxation, and expenditures. The Bureau of the Census co-operated with the Department of Commerce and Labor in the preparation of the appraisal of the commercial valuation of railway properties of the country.

The report of this work, issued as Bulletin 21 of the Bureau of the Census, is the most interesting and valuable exposition of the subject of railway valuations yet published, as it includes not only the report of this particular work, together with the results, tabulated by States, but appendices describing and discussing the work in States and foreign countries, and the work of valuation by railway men.

The results are of prime interest, as they show the valuation of all railway property in all the States, based on uniform methods of appraisal and distribution, which enables a comparison to be made with work done by the States.

The method adopted in this work was so radically different from that of the various State appraisals as to make a detailed description a matter of interest, and it is to be regretted that it cannot be included. The method is really a capitalization of net earnings.

Owing to the nature of the inquiry, namely, to determine what part of the wealth of the nation is devoted to railway transportation, it was obligatory on the appraisers to adopt a method which would disclose as nearly as possible the true market value.

Certain restrictions and limitations on the term, "value," and on the use of the resultant figures of the appraisal, are suggested by Professor Adams, as follows:

> "The valuation submitted in this report may be properly defined as the commercial value of property used by railways in connection with the business of transportation. By 'commercial value' is meant the estimate placed upon the worth of property regarded as a business proposition. This must, of course, be the market estimate and not the arbitrary estimate of a public official. The two fundamental considerations by which the market is influenced in placing a value upon property when bought or sold, are the expectation of income arising from the use of the property, and the strategic significance of the property. These two considerations are made the basis of the valuation of railway property submitted in this report. The material made use of in this valuation is, first, the operating and financial accounts of the railways; second, interrailway contracts and agreements; and, third, the published records of the stock market.
>
> "This is no place to enter upon a discussion of the nature and classification of different kinds of value, but a word of caution may be allowed in order to guard against an unwarranted use of the figures here submitted. The commercial valuation of railway property, in so far as it depends on income arising from the sale of transportation, is the result, among other things, of an established schedule of freight and passenger rates, from which it follows that such a valuation cannot be used for determining the reasonableness or unreasonableness of the rates in question. The solution of the rate problem demands a separate valuation of the physical property.

"Again, in so far as the Government is precluded by its political character from following commercial rules in the sale of any service which it renders, a commercial valuation which assumes that property is administered under the rules of private rather than public financiering, might differ from the valuation of the same property regarded as a public property. The purpose of this remark is to preclude a discussion of the problem of the Government purchase of railways on the basis of the values submitted in this report. It would of course be necessary to modify these values by considerations of public utility, in order to determine a public purchase price.

"Whether or not the commercial valuation here submitted can be used as the basis of assessing railway properties for the purpose of taxation depends entirely upon the taxing laws of the state for which the question is asked. If these laws confine the appraisal of railway property to its physical elements, the values here submitted would, in the case of prosperous roads, exceed an appraisal for the purpose of taxation. If, on the other hand, it is the purpose of the taxing law to appraise railway property at its true cash value, unusual or abnormal conditions being excluded, it may be that the commercial valuation of operating property submitted in this report fairly measures its appraisal for the purpose of taxation."

The methods are explained in the most minute detail by a series of papers in the Bulletin.

The work of Professor Adams and his associates is of great practical value in that it shows the discrepancy in the taxation laws of the different States as relating to railroad properties, and in that it gives a set of values determined by a uniform method, which, within reasonable limits, furnishes a check on the work of the State appraisals.

This method, of course, cannot be used for purposes of rate making, or of bond or stock restrictive legislation, but the general uniformity of its results with those of State appraisals, and the radical differences noted in the case of values for taxation in other States, lead very properly to the inference that a value determined by this method is very close to the truth.

The Extent of Appraisal Practise.

There have been many appraisals of property besides those reviewed in the foregoing pages. Several excellent contributions to valuation literature, as a result of the numerous water-works appraisals, are mentioned in the Appendix.

New Jersey and Nebraska have had railway appraisals in progress during 1909-10. At the time of writing, neither appraisal has gone far enough to add any points of interest to the subject, except as the appraisers in these two States discuss the subject and bring out new points.

Valuations of Street Railway property have been made in several cities, Cleveland, Ohio, Detroit and Milwaukee being the most recent.

The Cleveland and Milwaukee hearings have produced large records, and have tended to determine finally certain principles of valuation. Several valuations have also been made for corporations, among which may be mentioned that of The Toledo Railways and Light Company, by Messrs. Ford, Bacon, and Davis, and that for the New York, New Haven, and Hartford Railway, under the direction of John F. Stevens, M. Am. Soc. C. E.

This latter valuation offers some very interesting points, and, in view of Mr. Stevens' standing as a railroad engineer, the adoption by him of methods of inventory and field inspection would go far toward fixing a precedent which would be acceptable to the railroads. It is to be regretted that the interests of the road are such that it is not deemed wise by its President to discuss even the principles of this work at present.

In connection with the recent appraisal made by the City of Detroit, The Detroit United Railway made an independent examination and appraisal of its own property, with the double purpose of furnishing an inventory to the city and of checking the work of the staff employed by the city. This work for the railroad was done by officials and employees of the company, under the personal direction of Mr. R. B. Rifenberick. It is noteworthy for the completeness of its inventory, which goes into the most minute detail, and for the excellence of the maps and drawings which accompany it and show, not only every standard type of track, rail, and all buildings and machinery, but every piece of track and overhead special work on the entire system. This appraisal includes a most complete and exhaustive study of average unit costs. Inasmuch as this work is likely to be fully reviewed in the Courts in the near future, any further description would hardly be proper. It is not too much to say, however, that it probably stands as the most complete in every detail, as to inventory and records, of all American appraisals up to this date.

During the summer of 1910 the Railway Commission of Michigan ordered an appraisal of certain large electric-power properties of the

State. This work was done by Professor Mortimer E. Cooley, assisted by Mr. Henry C. Anderson and the writer. This appraisal, involving certain comparatively new corporations, made it possible to obtain a fairly definite solution of some of the problems relative to overhead charges.

It is evident that the demand for valuation work of a high character will increase, and that it will come, not only from States and cities, but from corporations. Much of the work done in the past has not been described in the publications of scientific societies; much very valuable work has secured only partial notice through reports of litigation; and it is undoubtedly true that the most complete and full discussions of the principles of valuation have been in the form of expert evidence before the Courts, and are buried in the mass of unprinted records of testimony.

Review of Some Methods of Valuation, and Some of the Criticisms on the Michigan Appraisal.

Much of the available literature on the subject of valuations is in the form of papers descriptive of water-works appraisals and arbitrations, many of which have been made, and a few of which have been the subject of valuable papers and discussions before learned societies.

Before the American Water-Works Association, D. W. Mead and J. W. Alvord, Members, Am. Soc. C. E., have presented papers* which have been quite fully discussed. The chief point of interest in these papers is the treatment of the intangible element termed "going value." Mr. Alvord advances the argument that, after the determination of physical present value, there should be added, to determine the fair value, two non-physical elements: the "going" or "business" value, and the franchise value. The first element is defined as that special value which is:

> "Built up * * * by the energy, perseverance and solicitation of the officers in charge, as distinct from the inert plant itself, * * *.
>
> * * * * * * *
>
> "The element of 'going value' has been before described as the element of growth in the plant irrespective of its physical condition. It is comparable somewhat to that indefinable quality known in other lines of business as 'Good Will'. Nevertheless it is something more than good will in water works business, as it represents what might be

---

**Proceedings*, Am. Water-Works Assoc., 1902.

more aptly described as 'connected good will', that is to say, the acquisition of customers who have invested considerable sums in actually connecting their premises with the plant of the company, and provided appliances for the use of the water which it can deliver."

The method advocated by Mr. Alvord as the most rational one for computing this value is described as follows:

"It is assumed that a new plant will be constructed, the inception of which is coincident with the data of arbitration. Such new plant is to be of an equal capacity with the older plant under consideration, and a due allowance of time in which to construct this new plant, and the necessary capital to be invested in it from time to time is estimated. At the completion of this new imaginary plant, it is assumed that it commences to obtain business in that community from those who are not previously accustomed to the free use of public water, except in a general way; that it is to require the business ability and consequent increase in number of customers which the earlier and older plant went through within the early years of its existence. An assumption of the amount of business thus created for each year for a period of years in advance is carefully computed and estimated by the board of arbitration. The losses of interest upon capital invested are duly fixed, as well as the first absence and later addition of revenue from hydrant rentals, and a table is prepared showing each year, the total business developed and the total losses, if any. After this is completed a forecast is made of the business of the older works for the same period of time in the future that it takes the business of the new works to equal the business of the old works. If the business of the old works is found to be a growing one it will be a longer period that the new works will require to overtake it than will be the case if the business of the older works is stationary or decreasing. In general, the differences which might be called the debits and credits of this new imaginary plant and the debits and credits of the older working plant are reduced to their present worth at the time of appraisement, and an estimate is made up which will adequately represent the financial advantage which the old works (already fully equipped and in running order and having a large number of profitable customers) will have over the new works, where everything must be built and customers secured.

"It is necessary in making this supposititious estimate of the new plant to consider it in no way a competitor of the older works; there is not supposed to be competition between the new and the old, but it is left to the experience of the board of arbitration to consider how long it would take the new company to build new works, and build up business for the new works, until they have overtaken the business of the old company should it continue to occupy the same territory."

Mr. Alvord's description of his method has been quoted fully, as it is an interesting one and has been often used. It is open to the very decided objection that it is purely theoretical, a rational method of computation, perhaps, but based on assumption throughout. It may be said to be a method which is within the field of pure speculation. Mr. Alvord, himself, says that where experience in financial matters and the financial management of water-works is not brought into the valuation, there is usually to be found guesses of the wildest character. Professor Mead, in discussing Mr. Alvord's method and agreeing that it is consistent and logical, says:

> "the method is by no means an exact one, and must necessarily lead to a very great divergence in opinions as to the 'going value,' in accordance with the assumptions on which it is based. * * * Its very logic is an element of danger, for if clearly presented from a biased stand-point to one previously unacquainted with its application, and if accepted without careful analyses it may lead to very unjust conclusions. If used, however, carefully and conscientiously with the desire to do justice to all concerned, it is a valuable method of estimating going value, and the only logical one with which the speaker is familiar."

In addition to the element of going or business value, Mr. Alvord considers the franchise value, and presents two methods for its determination:

First.—The physical value, depreciation, and going value are entirely neglected, and the entire valuation is fixed on the basis of its earning power throughout the remaining life of the franchise and its probable sale value.

The probable net revenue for each year of franchise life must be estimated and capitalized at a sum, which, if put at interest, would pay such yearly revenue and extinguish itself at the end of the franchise period. To this must be added the physical value of the plant at the end of the franchise period.

Second.—The cost of reproduction, depreciation, and present physical value are ascertained, and the going value computed. Then it is determined whether or not the net revenue is paying interest on a capitalized value greater than that indicated by the sum of the physical and business values. If such capitalized figure is less than this combined value, there is, of course, no franchise value; if it is more, there is a franchise value which should be determined by estimating, for the remaining years of the franchise, the excess income over and above that necessary to cancel all obligations (including interest on the physical and business values), and the reduction of these several sums to a basis of present worth.

A number of other articles and papers are listed in the Appendix. Many of these are of great value and are well worth careful perusal, but they offer no definite plan of valuation. Inasmuch as the general principles involved in the valuation of a water-works plant and a railroad plant are similar, it is advisable, in any exhaustive study of the subject, to review the articles descriptive of water-works valuation, and it is a matter of regret that greater consideration cannot be here given to some of the points raised by such engineers as George H. Benzenberg, Past-President, Am. Soc. C. E., Kenneth Allen, Arthur L. Adams, Emil Kuichling, Members, Am. Soc. C. E., and others in their various papers and discussions of this subject.

The *Railway Age*, the *Railroad Gazette*, the *Railroad Age Gazette*, and the *Railway Age Gazette* contain many editorials and articles on the valuation of railroad properties. These are written mainly from the standpoint of the railway official, and present many matters of interest which are worthy of study prior to undertaking a large appraisal. One series of articles in the *Railway Age Gazette** is a most masterly argument, and it is to be regretted that the author has not disclosed his identity.

The Michigan valuation has been discussed in two papers by Mr. Charles Hansel, whose connection with the work, as a member of the Board of Review, gave him probably a more intimate knowledge of it than anyone else, not connected with the actual working organization, who has undertaken to review the work. His first paper, published in 1901,† entitled, "What is the Value of a Railroad for Purposes of Taxation?" is a discussion of the work of Professors Cooley and Adams, written while the subject was fresh in his mind. His second paper, an able argument for a Government valuation, appeared in the *North American Review* in 1907. The one point to which special attention is drawn is Mr. Hansel's astonishing misconception of Professor Adams' plan of work. This misleading statement appears in the first paper and is reiterated in the second. It is of such a character that to pass it unchallenged would be doing great injustice to Professor Adams. He states Professor Adams' plan as follows: Capitalize net earnings and add to the present value of the physical appraisal as found by Professor Cooley.

---

* Commencing with the issue of January 22d, 1909.

† The *Railroad Gazette*, April 19th, 1901, Vol. XXXIII, No. 16, p. 271.

"The result would be that in case the present value per mile as determined by Professor Cooley is found to be $15 000, and the net earnings by Professor Adams are found to be $1 000, this capitalized at 5 per cent. would equal $20 000, and added to the present value would make $35 000, which would be the sum upon which taxes were to be levied. In other words, if the company actually earns $1 000 it increases its value for purposes of taxation 20 times that amount. If, however, instead of having a net earning of $1 000 it spends that sum in improving the property, it has only increased its taxable property by $1 000."

This statement is not only inaccurate, but involves the other error of assuming that the appraisal figure was to be used for taxation. It was not. It was merely information to aid the legislature in framing new taxation laws. The chief error, however, is in assuming that Professor Adams added the value of the property, as determined by a capitalization of net earnings (which *per se* is a well-recognized method of valuation), to the value of the physical property. This error probably is due to the flood of criticism which at the time was aimed at any form of non-physical valuation.

Professor Adams finds the net earning in Mr. Hansel's example to be $1 000 per mile. From this, in the method actually used, he deducts an annuity for the support of invested capital, which he assumes to be the present value found by Professor Cooley. In the example given by Mr. Hansel he would deduct 4% on $15 000, or $600 per mile, leaving $400 per mile as surplus, or the earnings due to non-physical elements of value. This, capitalized at 5%, would give $8 000 per mile, which, added to Professor Cooley's figure of Present Value, would make $23 000 per mile, instead of $35 000, as stated by Mr. Hansel.

The most recent criticism of the Michigan valuation work was in an address* before the New York Traffic Club in January, 1909, by Mr. W. H. Williams, Third Vice-President of the Delaware and Hudson Company. This address is devoted to an attack, not only on the work of the Michigan appraisal, but on Professor Adams' work and on the propriety of valuation work being undertaken for any reason. The arguments advanced in this address are such that a discussion of them becomes almost necessary in any complete review of the Michigan work, and it contains so many statements which are erroneous that it would hardly be permissible to pass them without comment. The manifest impatience with all forms of governmental interference with corporations, which so often characterizes the utterances of prominent railway officials, appears in this paper to a marked degree. After stating that the present agitation for a physical valuation appears to be the result of a misconception, on the part of the Interstate Commerce Commission, of Section 20 of the Act to Regulate Commerce, and quoting Professor Adams' suggestion of an inquiry, he says:

---

* *Railroad Age Gazette*, April 2d, 1909, p. 761.

"Subsequently, the desire of Governor Pingree to find a means of increasing railway taxation in Michigan gave Professor Adams an opportunity to experiment with his project within the limits of that State."

This is a direct imputation of an improper motive, not only to Governor Pingree, but to Professor Adams. As stated elsewhere, the investigation was to determine whether the railroads were paying taxes on the same basis of valuation as other property in the State—an absolutely proper proceeding. Professor Adams was associated with the Michigan appraisal, but had no connection whatever with the "physical valuation," to which such objection is taken, and his appointment was made after the work of physical valuation had been fully outlined and was well under way.

The opening statement is followed by a brief *résumé* of the recommendations of the Interstate Commerce Commission and President Roosevelt, and of bills introduced in Congress, also by quotations from Bulletin 21, describing the methods of valuation used in Michigan and a showing that practically a similar basis was used in other States. Mr. Williams then summarizes his objections to the Michigan work:

"(1) No allowance is made for discount on securities sold.

"Discount is a partial capitalization of the commercial risk had in making the investment, and it increases or decreases in proportion to the probability of the earning power of money under existing conditions. Not only is this practice justified by long-established commercial usage, but also by judicial determination."

The correctness of this position cannot be conceded on any grounds of economics or accountancy. It is answered conclusively in an article,* elsewhere referred to, as follows:

"There is considerable diversity of opinion as regards the proper treatment of discount on securities sold. There is a distinction between bonds, representing corporate indebtedness and having a definite limitation as to the time of their redemption, and share capital, representing ownership and which as a rule is irredeemable. In relation to the former there can be but one tenable view. If a company can market its 50-year 4 per cent. bonds at 90 per cent. of par, it means that the company's credit is on a 4½ per cent. basis; that it could market a like security paying 4½ per cent. at par. If it elects to issue at the lower rate it is merely sacrificing principal for the sake of a reduction in the annual interest charge; in other words, it is prepaying interest which would accrue during the life of the issue. If $10 000 000 par value were issued at 90 per cent., the discount would amount to $1 000 000, and the saving in interest to $50 000 per year, or $2 500 000 in 50 years. Obviously the company cannot claim the privilege of capitalizing the discount, while thereby availing itself of the reduction in interest. If such a course were legitimate in the case of a 5 or 10 per cent. discount, it would be equally so if the discount were 50 or 75 per cent., when the absurdity of the proposition would be perfectly apparent. The somewhat general practice of prorating the discount, as a charge against revenues, over the term of the obligation's existence is sound; but this should be done, not in equal installments, but on the basis of the appreciated value of the bond as it approaches par at maturity. There is no apparent objection to charging discount of this nature in a lump sum against an accumulated surplus. The capitalization of discount on stocks, involving as it does the introduction of fictitious values in capital assets, is wholly indefensible."

The writer has failed to note any particular "judicial determination" which approves of the charge of any such item to capital account.

"(2) The interest during construction (3 per cent.) is less than a fair and reasonable return on the investment."

The amount actually paid out for interest on money used during the period of construction will vary, of course, depending on the time of construction and the way in which payments on construction materials are made. On the basis of a rate of 6% per annum and construction lasting one year, only a very small portion of the construction cost will pay 6%, while the great items of rails, buildings, motive

---

Railroad Age Gazette, January 29th, 1909, p. 219.

power, and equipment will be put into the work from 90 days to 10 months after the commencement of work, and will actually bear but little interest. In the Michigan appraisal the assumption was made that all work must be replaced in one year, and that on long roads partial operation would commence as various sections of the line were completed; and 3% was agreed on as a fair average, perhaps having in mind Governor Pingree's "desire to increase railway taxation." Some assumption must be made. This one, that long roads, covering several years of construction work, are in Michigan put in partial operation as soon as built, is not unreasonable. Such an assumption clearly would not be proper in the case of long lines crossing mountains, or involving such a class of construction as to make it impossible to complete the property short of two or three years; and, in any such cases, the interest charge should be made sufficient to cover.

"(3) No allowance is made for working capital with which to carry on the business."

All the appraisals of physical property have been made on the basis of securing a figure representing the cost of reconstructing the property in the condition in which it existed on the date of the appraisal, including only items properly chargeable to capital, cost of road, and equipment. This is not such an item. The writer is of the opinion, however, that it is a proper one to determine and include in any report.

"(4) No allowance is made for wear and tear of material during the period of construction. Assuming eight years to be the life of a tie, and three years the period of construction, a substantial percentage of the period of usefulness is over before the road is in operation. The use of the rails before the track is put in proper line and surface hastens the time when they must be removed."

This deterioration is a necessary incident to any construction work. It has not been customary or usual to take account of it. To add to the amount capitalized on account of this item would be manifestly improper. The only way in which this could be cared for would be in an adjustment of the depreciation reserve when raised to cover that which takes place during the construction period. This reserve, later in the address, is objected to by Mr. Williams as improper accounting:

"(5) No allowance has been made for impact and adaptation. After the line is placed in operation, each fill will sink 1 ft. for every

10 ft. of height. The slope of cuts must be increased to prevent landslides and washouts. The ballast will pound into the roadbed, necessitating additional ballast to secure a standard cross-section."

Part of this objection is covered by the item, "Appreciation of Roadbed," discussed elsewhere. This, perhaps, is a proper item, but a comparatively small one. One of the examples cited is clearly maintenance. This objection is largely covered in the Michigan work by the contingency item.

"(6) A uniform price for earthwork was used, thus ignoring the varying character of soil and length of haul."

This is erroneous. On the Michigan appraisal prices were used for earth, loose rock, and solid rock. There is practically no classification in the Southern Peninsula of Michigan, or, in fact, on 90% of the mileage of the State. The price used was not much out of the way when considered as a fair average for the territory. The same was apparently true of other appraisals. It would not be a proper figure to use in an estimate based on 1909 prices, which are materially greater than those obtaining in 1890-1900.

"(7) A uniform price list for all materials was used, thus ignoring the source of supply and cost of delivery to point of use."

This, again, is not true. Differences were made between the Upper and Lower Peninsulas; and an exhaustive study was made of rates to different sections. It is believed that the prices adopted took all these points fully into consideration. It is true that no effort was made to use different unit prices as between counties, but, in a number of cases, differences in prices were made for different sections of the State, where either local conditions as to production of materials, or traffic rates, seemed to warrant.

"(8) No allowance was made for interference with work on account of labor troubles, condition of the weather, etc., which would vary materially in the different counties of the same state."

True. Nor is such allowance ever made in actual construction, beyond the contingency item. Such items are a frequent source of annoyance, delay, and sometimes of expense, but an expense difficult to separate and set up, and clearly belonging to contingencies.

"(9) No allowance is made for carrying charges until such time as the road was placed on a revenue basis."

True; and such item is not a part of a physical appraisal.

The foregoing nine points are classed as "among other things" open to criticism. The next two quoted paragraphs are introduced to indicate the "other things" as they appear. These are mainly non-physical or intangible elements of value, which, under the method of Professor Adams, are treated *en bloc,* and which, from their nature, it would be impossible to set out and value separately; therefore, no effort is made to answer them point by point, further than to say in general that, if there is any value attaching to these items, it was presumed to have been disclosed by the method of Professor Adams, and to suggest further that had Professors Cooley and Adams had such an advocate of intangible values ten years ago, their labors would have been lightened, as all arguments by railway officials at that time were against the use of any such elements of value in an appraisal.

> "No consideration has been given to the leasehold interests. * * * Therefore it will be seen there remains to be determined many questions vitally affecting the value of the property without regard to its value as a 'going concern.'
>
> "There should be no difference in the basis of arriving at the value, as a 'going concern,' of the property of a railway and any industrial establishment, nor should there be any difference in the basis of valuation for taxation [exactly what Governor Pingree maintained] or other purposes. There is common to both the value due to location, good will, etc."

While the remainder of the address in question contains no specific criticisms of methods of valuation, it does go into a discussion of sundry legal decisions; and conclusions are drawn quite at variance with those set forth elsewhere in this paper. The thing most noticeable in the entire address is the lack of a proper spirit of fairness, an apparent inability to state fully and fairly the position of the men whose views are being opposed, and an undue emphasis in quoting some public official whose views coincide for the time being with the theories which are being advocated. The fact that Mr. Williams quotes from an address of Hon. Robert H. Shields, President of the Michigan Tax Commission, a statement criticising the work of Professors Cooley and Adams, illustrates the latter point.

The statement is made again and again that the Michigan work was a physical valuation; that no attempt was made to secure a "fair value" (the language of the Courts), and that the value as a going concern was not attempted to be given. In no case is the statement made that Professor Cooley had charge of the physical valuation in Michigan, and that Professor Adams took this physical valuation, and, under his method, treated it as one element, and with it and other data derived from a study of the reports and earnings of the company, undertook to determine a "non-physical," "intangible," "franchise," or "going concern" value, which included all tangible elements, and which, added to the physical value, was assumed by Professor Adams to give the true value. Had such a statement been fairly made, no possible objection could be raised to the making of any number of points against the correctness of the methods used by Professor Adams.

"Certainly it cannot be denied that a road between New York and Chicago, 950 miles in length, passing through a manufacturing district, is of greater value than a road 1 200 miles in length, between the same cities, but passing through a hilly and undeveloped territory a portion of the distance, and through a farming section for a greater portion of the remaining distance; yet the advocates of a physical valuation would have us believe that there is no difference in the value of the two if they can be reproduced to-day at the same cost."

This statement is entirely unfair to every man who has been in responsible charge of valuation work in recent years in the United States. No theory has ever been favored by any honest-thinking advocate of a valuation. In the first place, no interstate valuations have ever been made, and no parallel case to the one assumed is to be found, except for very short sections of roads, a very marked instance having been referred to elsewhere in this paper. Such a condition as assumed would be reflected in the earnings of the companies to such an extent as to cause the non-physical element of Professor Adams as used in Michigan to correct largely or wholly the inequality and inaccuracy of the physical valuation; such at least was the theory, and, if carried to its logical end by the use of negative non-physical values, such would be the result.

The final arguments of Mr. Williams' address are devoted to an attack on the plan outlined by the Interstate Commerce Commission for valuation, and on some of the accounting methods of the Commission—points not proper to be discussed in this paper—but it is difficult indeed to read them without noting the apparently studied misrepresentation of the real attitude of Professor Adams and the Commission, and the evident object of the entire address to create a wrong impression regarding what has been done, and a prejudice against the men who have been engaged on State appraisal work and those who advocate the appraisal of properties as a proper step in the way of securing such information as will enable an intelligent consideration of the great corporation problems that must be solved.

The Determination of Elements of Value and Methods of Valuation by the Courts.

The preceding narrative of methods of appraisal work logically leads up to the question: Will these methods that have been adopted in various appraisal undertakings stand the test of the Courts? After all, the final seal of approval must be stamped on a method by the highest Courts before it can be said to be a definitely fixed and determined principle for general use in valuation.

In a careful perusal of many papers on this subject, quotations from judicial decisions will be noted which are literally correct as far as they go, but which are incomplete and often very misleading; and often such incomplete quotations are presented as to convey an entirely wrong impression of the full decision. In order that no such charge may lie against this paper, the quotations given are full enough to indicate clearly the intent of the Court, even at the expense of undue length.

An examination of all Federal and Supreme Court cases which bear on the subject of property valuation has been made, and quotations at length from some of the older cases, establishing precedent, together with citations to more recent decisions, are submitted. It is believed that the points of principle and method, in so far as they have been determined by the highest Courts, are quite fully set forth.

A study of the complete methods of the railroad valuation in Michigan, in connection with these decisions, discloses the fact that they comply with the requirements of the earlier cases that all matters affecting value be taken into consideration, and that in the more recent decisions the detailed methods adopted in the Cooley physical appraisal have been sustained as to very many points. In no case have any of such methods been unfavorably criticized, and, while at this date the Supreme Court has not squarely passed on the propriety of any method for securing non-physical or intangible values, it has fully sustained the general position of Professor Adams in several important points. In addition to the complete examination of Federal cases, certain very interesting and valuable State cases have been examined, and some of them are quoted.

These cases involve both matters of taxation and rate making. They cover railroads, water-works, gas-works, and other classes of public service corporations, and clearly demonstrate the fact that any analysis of the subject of property valuations must include all classes of corporations. Rate making and taxation in themselves are entirely separate and distinct from valuation, which is a necessary preliminary step in either undertaking. For this reason all references which are not of special interest in the valuation part of the problem are omitted.

The case of Smyth *vs.* Ames (169 U. S., 466) was an action to question the constitutionality of a statute of Nebraska establishing rates. It is of great interest, and, based on the ruling of the Court in this case, the appraiser in Washington and the appraisers in Nebraska have undertaken to secure first cost as an element of value. The decision holds that:

(1) A railroad corporation is a person within the meaning of the fourteenth amendment.

(2) A State enactment establishing rates that will not admit the carrier to earn such compensation as would be just to it and to the public, would deprive such carrier of its property and would be repugnant to the fourteenth amendment.

(3) Rates established by a State cannot be so conclusively determined by the legislature that they cannot become the subject of judicial inquiry.

The reasonableness of rates prescribed by a State for intra-state business must be determined without reference to the interstate business done by the carrier or the profits derived from that business.

This paper is not concerned with the question of rates which is discussed at length in this decision. It is, however, of special interest to note what the Court says in regard to the relation of the corporations to the people, and to elements of value.

"A railroad is a public highway, and none the less so because constructed and maintained through the agency of a corporation deriving its existence and powers from the State. Such a corporation was created for public purposes. It performs a function of the State. Its authority to exercise the right of eminent domain and to charge tolls was given primarily for the benefit of the public. It is under governmental control, though such control must be exercised with due regard to the constitutional guaranties for the protection of its property. * * * It cannot therefore be admitted that a railroad corporation maintaining a highway under the authority of the State may fix its rates with a view solely to its own interests and ignore the rights of the public. But the rights of the public would be ignored if rates for the transportation of persons or property on a railroad are exacted without reference to the fair value of the property used for the public, or the fair value of the services rendered, but in order simply that the corporation may meet operating expenses, pay the interest on its obligations, and declare a dividend to stockholders.

"If a railroad corporation has bonded its property for an amount that exceeds its fair value, or if its capitalization is largely fictitious, it may not impose upon the public the burden of such increased rates as may be required for the purpose of realizing profits upon such excessive valuation or fictitious capitalization, and the apparent value of the property and franchises used by a corporation, as represented by its stocks, bonds, and obligations, is not alone to be considered when determining the rates that may reasonably be charged."

(The Court here quotes 164 U. S., 578, Covington and Lexington Turnpike *vs.* Sanford.)

"A corporation maintaining a public highway, although it owns the property it employs for accomplishing public objects, must be held to have accepted its rights, privileges, and franchises subject to the condition that the government creating it, or the government within whose limits it conducts its business, may by legislation protect the people against unreasonable charges for the services rendered by it. It cannot be assumed that any railroad corporation, accepting franchises, rights, and privileges at the hands of the public, ever supposed that it acquired, or that it was intended to grant to it, the power to construct and maintain a public highway simply for its benefit, without regard to the rights of the public. But it is equally true that the corporation performing such public services, and the people interested in its financial affairs have rights that may not be invaded by legislative enactment in disregard of the fundamental guaranty for the protection of property. The corporation may not be required to use its property for the benefit of the public without receiving just compensation for the services rendered by it. How such compensation may be ascertained, and what are the necessary elements in such inquiry, will always be an embarrassing question.

"We hold, however, that the basis of all calculations as to the reasonableness of rates to be charged by a corporation maintaining a highway under legislative sanction must be the fair value of the property being used by it for the convenience of the public. And in order to ascertain that value the original cost of construction, the amount expended in permanent improvements, the amount and market value of its bonds and stocks, the present as compared with the original cost of construction, the probable earning capacity of the property under particular rates established by the statute, the sum required to meet operating expenses, are all matters for consideration, and are to be given such weight as may be just and right in each case. We do not say that there may not be other matters to be regarded in estimating the value of the property. What the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience. On the other hand, what the public is entitled to demand is that no more be exacted from it for the use of a public highway than the services rendered by it are reasonably worth."

The body of this decision is quoted at length to show:

First. That the Court reiterates the relation of the people to the corporation, as defined by Covington and Lexington Turnpike Road *vs.* Sanford (164 U. S., 578) and by Stone *vs.* Farmers' Loan and Trust Company (116 U. S., 307).

Second. That the basis for computing a fair rate is the fair value of the property, which must be arrived at by a computation or series of computations taking into account many different factors.

Third. That while the Court mentions certain things that may serve as indices of value, which are to be taken into account and given due weight, the Court does not outline or define any method of arriving at a value, but does recognize it as an embarrassing question.

Fourth. That no such stress has been laid by the Court on original cost as has been construed by some appraisers.

The principles enunciated in Smyth *vs.* Ames are reiterated by the Court in San Diego Land Company *vs.* National City (174 U. S., 739), with the further ruling:

"The contention of the appellant in the present case is that, in ascertaining what are just rates, the Court should take into consideration the cost of its plant; the cost per annum of operating the plant, including interest paid on money borrowed and reasonably necessary to be used in constructing the same; the annual depreciation of the plant from natural causes resulting from its use; and a fair profit to the Company over and above such charges for its services in supplying the water to consumers, either by way of interest on the money it has expended for the public use, or upon some other fair and equitable basis. Undoubtedly, all these matters ought to be taken into consideration and such weight given them, when rates are being fixed, as under all the circumstances will be just to the company and to the public. The basis of calculation suggested by the appellant is, however, defective in not requiring the real value of the property and the fair value in themselves of the services rendered to be taken into consideration. What the company is entitled to demand, in order that it may have just compensation, is a fair return upon the reasonable value of the property at the time it is being used for the public. The property may have cost more than it ought to have cost, and its outstanding bonds for money borrowed, and which went into the plant, may be in excess of the real value of the property. So that it cannot be said that the amount of such bonds should in every case control the question of rates, although it may be an element in the inquiry as to what is, all the circumstances considered, just to both the company and the public."

In the case of Columbus Southern Railway *vs.* Wright (151 U. S., 479), the Court quotes approvingly from Franklin Company *vs.* Railroad (12 Lea (Tenn.), 521-537-538-539), and shows that the doctrine quoted had already been enunciated by the Supreme Court in the State Railroad Tax Cases (92 U. S., 575-607). The Court quotes as follows:

"The property of a railroad company for purposes of taxation consists of its realty, its local personalty, its rolling stock, its choses in action, and its franchises. The franchise is a privilege conferred by the charter of incorporation, namely the right to exercise all the powers granted in the mode prescribed for the purpose of profit. It is a unit not confined to any one county in which it may be exercised.

* * * * * * *

"Obviously, after ascertaining the value of the entire franchise in the State as a unit, no more approximate or just division of this value can be made for purposes of taxation than to allot it among the counties through which the track runs in proportion of the entire length of track in the county to the entire length of track in the State. * * *

"The roadway itself of a railroad depends for its value upon the traffic of the company and not merely upon the narrow strip of land appropriated for the use of the road, and the bars and cross-ties thereon. The value of a roadway at any given time is not the original cost, nor, *a fortiori,* its ultimate cost after years of expenditure in repairs and improvements. On the other hand, its value cannot be determined by ascertaining the value of the land included in the roadway assessed at the market price of adjacent lands, and adding the value of the cross-ties, rails, and spikes. The value of land depends largely upon the use to which it is put and the character of the improvements upon it."

The mileage basis of apportionment is sustained in the following and other cases:

State Railroad Tax Cases	92 U. S., 608
Delaware Railroad Tax Case	18 Wall., 206
Erie Railway *vs.* Pennsylvania	21 Wall., 492
Western Union Telegraph Company *vs.* Mass.	125 U. S., 530
Pullman Palace Car Company *vs.* Pennsylvania	141 U. S., 18
Main *vs.* Grand Trunk Railway	142 U. S., 217
Pittsburg, Cincinnati, Chicago and St. Louis Railway *vs.* Backus	154 U. S., 430

Therefore this basis of division of values between territorial units appears to be well established by precedent. This is in a measure unfortunate, as certain classes of property cannot be apportioned equitably in this way, unless the value of a railroad be determined, and then that value allocated between different territorial units in proportion to mileage, without any regard to the location of any structure or series of structures in any State or county, the track mileage basis must be looked upon as a method of apportionment which is subject to modification or which will lead to error.

In an Indiana tax case, Cleveland, Cincinnati, Chicago, and St. Louis Railway *vs.* Backus (154 U. S., 444), the late Justice Brewer, of the Supreme Court, in handing down the judgment, said:

> "The true value of a line of railroad is something more than an aggregation of the values of the separate parts of it, operated separately. It is the aggregate of those values plus that arising from a connected operation of the whole, and each part of the road contributes not merely the value arising from its independent operation, but its mileage proportion of that flowing from a continuous and connected operation of the whole. * * * The value of property results from the use to which it is put, and varies with the profitableness of that use, past, present and prospective, actual and anticipated. There is no pecuniary value outside that which results from such use. * * *
>
> "In the nature of things it is practically impossible, at least in respect to railroad property, to divide its value and determine how much is caused by one use to which it is put and how much by another. Take the case before us, it is impossible to disintegrate the

value of that portion of the road within the State of Indiana and determine how much of that value springs from its use in doing interstate business and how much from its use in doing business wholly within the State. An attempt to do so would be entering upon a mere field of uncertainty and speculation."

In the Michigan cases, the principal one being Michigan Central Railroad *vs.* Powers (201 U. S., 245), the question of method of valuation was not passed on by the Courts for the reason that, after the evidence was in, and during the argument, counsel for the railroad admitted that the Cooley valuation was as correct a figure as it was possible to secure under then existing conditions, methods and rates of taxation being the issue.

It is thus seen that the Supreme Court of the United States was not, in any of the earlier cases, required to pass squarely on the propriety of any method of arriving at a "fair value," and consequently had not, prior to 1909, defined any hard and fast rules of procedure in determining such value. The Circuit Courts have passed on kindred questions in a few cases, among which San Diego Land and Town Company *vs.* National City (74 Fed., 83), and San Diego Land and Town Company *vs.* Jasper (110 Fed., 714) hold as above, and cite most of the cases referred to. In the latter case the Court says:

"The actual value of such property obviously depends upon a variety of considerations—among them the actual and prospective number of consumers—and is no more unchangeable than the value of any other kind of property."

As an illustration, there is cited the effect of a year's drouth on an irrigation plant as temporarily affecting the value of property.

In the case of Cotting *vs.* Kansas City Stock Yards (82 Fed., 839) the Circuit Court touches on one very interesting argument, in the light of some of the methods of valuation advocated by railway managers and some of the criticisms of recent valuation work.

"Different methods of estimating the value of property may properly be employed when it is valued for different purposes. When a valuation is placed on property which has become affected by a public use, for the purpose of ascertaining whether the maximum rate of compensation fixed by law for its use is reasonable or otherwise, it is obvious that the income derived therefrom by the owner before it was subjected to legislative control cannot always be accepted as a proper test of value because the compensation which the owner charged for its use may have been excessive and unreasonable. Again, when property has been capitalized by issuing stock, neither the market value nor the par value of the stock can be accepted in all cases as a proper criterion of value, because the stock may not represent the money actually invested, and furthermore because the property may have been capitalized mainly with reference to its income producing capacity, on the assumption that it is ordinary private property which the owner may use as he thinks proper without being subject to legislative control. On the other hand, however, when property is valued for the purpose last stated, it is clear that the owner thereof is entitled to the benefit of any appreciation in value above the original cost and the cost of improvements, which is due to what may be termed natural causes. If improvements made in the vicinity of the property, the growth of city or town where it is located, the building of railroads, the development of the surrounding country and other like causes, give property an increased value, the owner cannot be deprived of such income by legislative action which prevents him from realizing an income commensurate with the enhanced value of his property."

The language of the late Judge Brewer, sitting as one of the circuit judges in the case of National Water-Works Company *vs.* Kansas City (62 Fed., 853), is definite as to the necessity of taking into account some elements of intangible value, and is here quoted as giving the views of this eminent jurist:

"The difficult question, however, still remains; and that is, what is the 'fair and equitable value,' which by the statute and ordinance the city is to pay for the water-works? * * * We are not satisfied that either method, by itself, will show that which under all the circumstances can be adjudged the 'fair and equitable value.'

"Capitalization of earnings will not, because that implies continuance of earnings, and a continuance of earnings rests upon a franchise to operate the water-works. The original cost of construction cannot control, for original cost and present value are not equivalent terms. Nor would the mere cost of reproducing the water-works plant be a fair test, because that does not take into account the value which flows from the established connections between the pipes and buildings of the city. * * * A complete system of water-works, such as the company has, without a single connection between the pipes in the streets and the buildings of the city would be a property of much less value than the system connected as it is with so many buildings and earning, in consequence thereof, the money which it does earn. The fact that it is a system in operation, not only with a capacity to supply the city but actually supplying many buildings, in the city—

not only with a capacity to earn but actually earning—make it true that the 'fair and equitable value' is something in excess of the cost of reproduction."

The foregoing authorities cover practically all the older cases in the Federal Courts. These cases have been examined, and such of the subject matter has been quoted as would show the conclusions of the Courts as to what constitute the various elements of true value. The latest Federal decision bearing on the subject, and in many ways the most replete with argument, is the case of Consolidated Gas Company *vs.* City of New York (157 Fed., p. 849), which was decided in December, 1907.

In this case the valuation was determined by the master:

1.—A valuation of tangible assets, consisting of real estate, plant, mains, services, meters and miscellaneous equipment, and the property of subsidiary companies, the whole aggregating $63 357 000. Of this an allowance of $3 616 000 was made by the master for working capital, and this entire amount was treated as tangible property.

2.—Finally, an intangible value of $20 000 000 was assigned by him to the franchise and good will.

Objections were raised, as follows:

(*A*) Land values represent no original investment by the Company, do not indicate land especially appropriate for the manufacture of gas, and increase the apparent assets without increasing the earning power.

(*B*) The values of physical property are not original cost, but are cost of reproduction less depreciation.

(*C*) Some of the property cost more than new articles of the same kind at the time of inquiry. Some are of designs not now favored by the scientific and manufacturing world.

The disputed questions involved, as far as tangible property is concerned, were:

1.—Whether the values ascribed to the several enumerated items are based on competent and persuasive evidence.

2.—Whether the method of valuation pursued by the master is in accordance with law.

3.—Whether the items of property are "employed" (in the legal signification of the word) in the production of gas.

The first, a question of fact, is found affirmatively, and the evidence was found to be competent.

The second question is one of law, and, quoting from the cases cited in this paper, the Court holds as follows:

"This method of valuation correct * * * upon reason it seems clear that in solving this equation the plus and minus quantities should be equally considered and appreciation and depreciation treated alike. * * * The value of the investment of any manufacturer, in plant, factory, or goods, or all three, is what his possessions would sell for upon a fair transfer from a willing vendor to a willing buyer, and it can make no difference that such a value is affected by the efforts of himself or others, by whim or fashion, or (what is really the same thing) by the advance of land values in the opinion of the buying public. It is equally immaterial that such value is affected by difficulties of reproduction. If it be true that a pipe line under the New York of 1907 is worth more than was a pipe line under the city of 1827, then the owner thereof owns that value, and that such advance arose wholly or partly from difficulties of duplication created by the city itself is a matter of no moment. Indeed, the causes of either appreciation or depreciation are alike unimportant if the fact of value be conceded or proved; but that ultimate inquiry is oftentimes so difficult that original cost, and reasons for changes in value, become legitimate subjects of investigation as checks upon expert estimates, or bookkeeping, inaccurate and perhaps intentionally misleading. * * *

"The so-called money value of real or personal property is but a conveniently short method of expressing present potential usefulness, and 'investment' becomes meaningless if construed to mean what the thing invested in cost generations ago. Property, whether real or personal, is only valuable when useful. Its usefulness commonly depends on the business purposes to which it is or may be applied. Such business is a living thing, and may flourish or wither, appreciate or depreciate; but, whatever happens, its present usefulness, expressed in financial terms, must be its value. * * * It is not to be inferred that any American government intended when granting a franchise, not only to regulate the business transacted thereunder, and reasonably to limit the profits thereof, but to prevent the valuation of purely private property in the ordinary economic manner, and the property now under consideration is as much private property as are the belongings of any private citizen. Nor can it be inferred that such government intended to deny the application of economic laws to valuation of increments earned or unearned, while insisting on the usual results thereof in the case of equally unearned and possibly unmerited depreciation.

"I think the method of valuation applied by the report to land, plant, mains, services, and meters lawful. To 'working capital, Coke and Coal Company, and Astoria' the above considerations are not applicable, and these items will be treated separately."

The Court's review of the third question raises no points of special interest as to valuation.

The question as to amount of "working capital" is taken up, and that term is defined as:

> "The amount of cash necessary for the safe and convenient transaction of a business, having regard to the owner's ordinary outstandings both payable and receivable, the ordinary condition of his stock, or supplies in hand, the natural risk of his business, and the condition of his credit; and unless these matters, and perhaps others, be looked into, no comparison can be drawn between one business and another, or even between those of the same general nature."

In this instance it is of interest to note that the Court reduced the "working capital" from $3 616 000 to $1 616 000.

Perhaps the most novel and interesting part of this decision is that dealing with the intangible elements of value. The master was unable to separate the two elements, good will and franchise value, but gave their combined value.

> "From the testimony I think it apparent that what is here meant by good will is the organization of complainant, long established, and doubtless well manned and equipped. Such organization is clearly of value, because without it neither tangible nor intangible property can be profitably managed. Yet the organization itself is but a method of utilizing that which is invested, it is really dependent for its existence and continuance upon the franchise, without which there can be no useful organization. Tangible property has a certain value entirely apart from franchise or right to continue business, but good will in the sense of the organization for the business of furnishing gas, can have no existence whatever apart or detached from the franchise conferring the necessary privilege. Would any one think of capitalizing good will of this kind and distributing its assumed value in the shape of new shares among stockholders new or old? I think the most ingenious financier could not imagine such a proceeding, and, if this good will be not property capable of such capitalization and distribution, I do not think it property capable of capitalization as against the State.
>
> "Finally, this claim of good will seems to forget that for many years the price and distribution of complainant's gas has been regulated by law. A citizen is entitled to have a clean street before his house because he pays taxes, *inter alia,* for that purpose. He is much more plainly entitled to have complainant's gas in his house because the

company must give it to him if he pays for it. I think it apparent that the conceivable good will of a gas company in this city is about equal to that of the street-cleaning department of the municipal government."

Is a public service corporation entitled to add the value of its franchise to the assets from which a fair return may lawfully be demanded? This question is taken up and discussed exhaustively by the Court (157 Fed., 872 to 879), and while it is clear in reading his judgment that he does not believe it sound doctrine to invest a franchise with value, yet, after citing a large number of cases, he reaches the conclusion that he is "compelled" to consider franchises, not only as property, but as productive and inherently valuable property, and to add their value, if ascertainable, to complainant's capital account before declaring the rate of return.

This case went to the Supreme Court of the United States, where, under the title Willcox *vs.* Consolidated Gas Company (212 U. S., 19), citation is made to many cases in connection with the matter of franchise value. The decision of the Court is:

"The value of real estate and plant is to a considerable extent a matter of opinion, and the same may be said of personal estate when not based upon the actual cost of material and construction. Deterioration of the value of the plant, mains, and pipes is also to some extent based upon opinion. All these matters make questions of value somewhat uncertain."

The Supreme Court permitted the tangible values found by the lower Court to stand. It concurred with the lower Court in that it was not a case for a valuation of good will. It concurred with the lower Court in holding that the company was entitled to the benefit of any increase in tangible values, and that such increases should appear in the appraisal. It did not agree with the Court in the increase of franchise value above that which was capitalized in 1884, with the consent of the State of New York, and reduced the franchise value figure to $7 781 000. On this basis, the estimated return, under the new rate on the valuation of $55 612 435, was 5½%, which rate, in view of all the circumstances, is held to be not confiscatory and to be a not unreasonable return on the investment. The franchise value, as commented on in these cases, is referred to at considerable length in the following pages.

On January 4th, 1909, the case of Knoxville *vs.* Water Company (212 U. S., 1) was decided. This, in some respects, is of greater value to the engineer than any others cited, in its determination of methods. In this the appraisement of the tangible property was made in minute detail, the sum of $10 000 was added for "organization, promotion, etc.," and $60 000 for "going concern."

"The latter sum we understand to be an expression of the added value of the plant as a whole over the sum of the values of its component parts, which is attached to it because it is in active and successful operation and earning a return. We express no opinion as to the propriety of these two items in the valuation of the plant for the purpose for which it was valued in this case, but leave that question to be considered when it necessarily arises. We assume without deciding, that these items were properly added in this case. This valuation was determined by the master by ascertaining what it would cost to reproduce the existing plant as a new plant. The cost of reproduction is one way of ascertaining the present value of a plant like that of a water company, but that test would lead to obviously incorrect results if the cost of reproduction is not diminished by the depreciation which has come from age and use. * * * The cost of reproduction is not always a fair measure of the present value of a plant which has been in use for many years. The items composing the plant depreciate in value from year to year in a varying degree. Some pieces of property, like real estate for instance, depreciate not at all, and sometimes, on the other hand, appreciate. But the reservoirs, the mains, the service pipes, structures upon real estate, stand-pipes, pumps, boilers, meters, tools, and appliances of every kind begin to depreciate with more or less rapidity from the moment of their first use. It is not easy to fix at any given time the amount of depreciation of a plant whose component parts are of different ages with different expectations of life. But it is clear that some substantial allowance for depreciation ought to have been made in this case.

"The company's original case was based upon an elaborate analysis of the cost of construction. To arrive at the present value of the plant large deductions were made on account of the depreciation. This depreciation was divided into complete depreciation and incomplete depreciation. The complete depreciation represented that part of the original plant which through destruction or obsolescence had actually perished as useful property. The incomplete depreciation represented the impairment in value of the parts of the plant which remained in existence and were continued in use. It was urgently contended that in fixing upon the value of the plant upon which the company was entitled to earn a reasonable return, the amounts of complete and incomplete depreciation should be added to the present value of the surviving parts. The Court refused to approve this method, and we think properly refused. A water plant with all its additions begins to depreciate in value from the moment of its use. Before coming to the question of profit at all the company is entitled to earn a sufficient sum annually to provide not only for current repairs but for making good the depreciation and replacing the parts of the property when they come to the end of their life. The company is not bound to see its property gradually waste, without making provision out of earnings for its replacement. It is entitled to see that from earnings the value of the property invested is kept unimpaired, so that at the end of any given term of years the original investment remains as it was at the beginning. It is not only the right of the company to make such a provision but it is its duty to its bond and stockholders, and, in the case of a public service corporation at least, its plain duty to the public. If a different course were pursued the only method of providing for replacement of property which has ceased to be useful would be the investment of new capital and the issue of new bonds or stock. * * * If, however, a company fails to perform this plain duty and to exact sufficient returns to keep the investment unimpaired, whether this is the result of unwarranted dividends upon over issues of securities, or of omission to exact proper prices for the output, the fault is its own. When, therefore, a public regulation of its prices comes under question, the true value of the property then employed for the purpose of earning a return cannot be enhanced by a consideration of the errors of the management which have been committed in the past."

The Court holds that there was error in only considering the operations of the company for a period of one year, and that this should have extended to enough time to remove danger of abnormal business conditions and observe the effects of certain ordinances.

The decision of the Supreme Court, in the Omaha Water-Works case, decided on May 31st, 1910 (*Supreme Court Reporter,* July 1st, 1910), is of general interest in its discussion of the procedure of appraisers in making a water-works appraisal, and in the distinction drawn between appraisals and arbitrations; but it does not touch on appraisal methods or elements of value, except to discuss "going values." The language of Judge Lurton on this point is as follows:

"The option to purchase excluded any value on account of unexpired franchise, but it did not limit the value to the bare bones of the plant, its physical properties, such as its lands, its machinery, its water-pipes or settling reservoirs, nor to what it would take to reproduce each of its physical features. The value, in equity and justice, must include whatever is contributed by the fact of the connection of the items making a complete and operating plant.

"The difference between a dead plant and a live one is a real value, and is independent of any franchise to go on, or any mere good will as between such a plant and its customers. That kind of good will, as suggested in Willcox *vs.* Consolidated Gas Company (212 U. S., 19), is of little or no commercial value when the business is, as here, a natural monopoly, with which the customer must deal, whether he will or not. That there is a difference between even the cost of duplication, less depreciation, of the elements making up the water company plant and the commercial value of the business as a going concern is evident. Such an allowance was upheld in National Water Works Company *vs.* Kansas City (62 Fed., 853), where the opinion was by Mr. Justice Brewer. [This decision is quoted in the foregoing pages.] We can add nothing to the reasoning of the learned Justice, and shall not try to. That case has been approved and followed in Gloucester Water Supply Company *vs.* Gloucester (179 Mass., 365, and 60 N. E., 977), and Norwich Gas and Electric Company *vs.* Norwich (76 Conn., 565). No such question was considered in Knoxville Water Company (212 U. S., 1) or in Willcox *vs.* Consolidated Gas Company (212 U. S., 19). Both cases were rate cases and did not concern the ascertainment of value under contracts of sale."

The writer does not read into the language of this decision an approval of a separate element of value to be called "going concern value" or "going value" in addition to other non-physical values, but rather a recognition of the fact that certain non-physical elements of value, by whatever name they may be called, must be taken into account in arriving at the fair and equitable final figure of value of a live and operating concern for the purpose of carrying out a contract of sale.

It appears to be doubtful whether the Court can be construed as approving such an element of value in rate cases.

It thus appears that the United States Courts have laid down a few rules, which may be regarded as fixed and definite and must be followed, but that many important questions have not yet been decided. The value to be determined must be a "fair value" of the property being used for the convenience of the public. The par value of stocks and bonds may not alone be considered (although it may be considered), the market value of stocks and bonds, original cost plus cost of additions, the probable earning capacity, the cost of reproduction, depreciation, appreciation, all these, and any others that will throw light on the "fair value" must be taken into account and given the weight to which they are entitled. Any fictitious book values due to over-issues of stock and bonds are to be given no weight, but the appraisal must give the fair value, in the light of all the facts, of the property in actual use at the time of the appraisal.

There are several decisions of the State Supreme Courts which discuss these subjects, but an examination of a number of these gives practically nothing more, in the way of definite conclusions as to method, than has been cited. Perhaps the most complete and painstaking consideration of appraisal problems by any Court was that given by Judge Savage of the Supreme Court of Maine (97 Maine, 185, and 99 Maine, 371). These were neither rate cases nor taxation cases, but proceedings under statute to require from the Court instructions to a board of appraisers appointed to value the plants. In the later or Brunswick case, Judge Savage elucidates a number of points left not altogether clear in the Waterville case. The Brunswick decision contains some interesting views on "going value," and the Court's remarks on the general difficulties in making rules for an appraisement are exactly to the point:

> "There are many difficulties, if not dangers, in attempting to formulate rules which are to be applied to facts not yet ascertained. While it may be easy enough to state rules in the abstract, it is much more satisfactory in an opinion of the court, to express them in terms which are applicable to the facts in the precise case in hand. * * * It must be always understood that our answers to these questions are intended to be given only in the most general and comprehensive terms, which may, or may not, be found to be fitted to the facts which may subsequently be developed. No other course would be wise or safe. * * * A public service property may or may not have a value independent of the amount of rates, which for the time being may be changed. A public service company may, under some circumstances, be required to perform its services at rates prohibitive of a fair return to its stockholders, considering their property as an investment merely. * * *
>
> "Now, what is the property which the district has taken by power of eminent domain? In the first place it is a structure, pure and simple, consisting of pipes, pumps, engines, land rights, and water rights. As a structure, it has value independent of any use, or right to use, where it is, a value probably much less than it cost, unless it can be used where it is, that is, unless there is a right to use it. Nevertheless, it has value as a structure. But, more than this, it is a struc-

ture in actual use, a use remunerative to some extent. It has customers, it is actually engaged in business, it is a going concern. The value of the structure is enhanced by the fact that it is used in, and in fact is essential to, a going concern business. We speak sometimes of a going concern value as if it is, or could be, separate and distinct from structure value—so much for structure and so much for going concern. But this is not an accurate statement. The going concern part of it has no existence except as a characteristic of the structure. If no structure, no going concern. If a structure in use, it is a structure whose value is affected by the fact that it is in use. There is only one value. It is the value of the structure as being used. That is all there is of it."

The Court then argues that, as the structure is being used under authority and by virtue of franchises, it is more valuable. The franchise, however, is limited; other and competing franchises may be granted; a franchise may exist entirely independent of a structure. He holds that the structure is more valuable with the franchise.

"It is a structure in actual use, and with a right on the part of the owner to use it and to charge reasonable rates to customers for services rendered. It is threefold in discussion but it is single in substance."

This case is largely taken up with a discussion of the reasonableness of rates which furnish a basis for the estimate of value. There is no specific attempt to describe methods of procedure. That is left to the appraisers. These two Maine Cases, together with a valuable paper* thereon by Leonard Metcalf, M. Am. Soc. C. E., constitute an extremely valuable addition to the literature of appraisements.

It is clear, from a study of all the cases referred to in this paper, that the Courts have laid down a line of precedent which is equitable and just, that the interests of both public and corporations will be safeguarded, and that the likelihood of any unfair or improper valuations passing the scrutiny of the Supreme Court is but remote.

PHYSICAL VALUES AND METHODS FOR THEIR DETERMINATION.

All the foregoing narrative of methods adopted in recent valuations, review of judicial opinions, and comment on the expressed opinions of various engineers and railway officials, is presented as being proper and necessary to support the contention that the Michigan valuation, while not the first appraisal work, was the first valuation work of large magnitude undertaken by any State; that it was a work which established many precedents; and that the complete discussion of methods and principles in connection with and following this appraisal has given it probably a greater general value than any similar undertaking. The Wisconsin work, which immediately followed that of Michigan, was along lines similar to those of the Michigan physical valuation, and carried the work forward, adding to and strengthening certain of its features. Without any impropriety, it may be claimed that these two appraisals have laid down the general lines on which this class of engineering effort will be largely directed in the future.

---

* *Transactions*, Am. Soc. C. E., Vol. LXIV, p. 1.

It is desirable, in closing this paper, to indicate such general methods of procedure in valuation practice as may be said to have been thoroughly established by precedent, and to present such argument as will support the contention that such methods are proper.

The fact has been emphasized, again and again, by every writer on the subject, that problems of this class are not capable of exact mathematical solution; that, no matter how much care may be exercised in the execution of the work, the result is tempered by the personal judgment of the men engaged on it, and that only when it is executed by men of experience, sound judgment, and high moral worth can it have a definite, final, and just result.

This feature of appraisal work cannot be too strongly emphasized. The value of the work depends on the character of the men doing it, their experience in design, construction, and operation of properties, and their absolute fairness and freedom from prejudice.

That there will be many large valuations undertaken in the near future, there appears to be no doubt. These valuations will be made as a necessary preliminary to three classes of corporate control: rate-making, taxation, and the regulation of capitalization.

The Courts hold that the value must be "the fair value of the property used for the public," and that the corporation:

"may not impose upon the public the burden of such increased rates as may be required for the purpose of realizing profits upon [such] excessive valuation or fictitious capitalization." (Smyth *vs.* Ames.)

This language is repeated, again and again, so that it is clear that any valuation, to be sustained by the Courts, should:

1.—Be based on a careful study and analysis of all the information applicable to the case in hand; and

2.—That it must separate the various elements so that every step of the work may be reviewed and supported.

Public interest demands that, in any valuation, certain figures shall appear which shall show the amount of *bona fide* capital actually existing in the property at the date of appraisal.

The fact that a given amount of money was invested in building a railroad in 1880, and that certain other sums were spent for additions in subsequent years, does not necessarily indicate that these amounts of capital will still be found in the property in 1910.

The removal of timber from surrounding lands, the destruction of industries and the removal of tracks leading thereto, the destruction of equipment and facilities, the depreciation in value of adjacent property, along with wear and tear, and obsolescence, have gone to effect the destruction or loss of capital on many Michigan railroads. The case in 212 U. S., 1, clearly directs that the valuation must not take into account this destroyed capital, but must return a "fair value of the property as it is."

On the other hand, the amount of money actually spent in producing a given property in the past may be far below the present value. The appreciation of value of lands by reason of development of cities and growth of industries, the increase in cost of the materials entering its construction, and many other causes, may lead to an appreciation of the value of the property, and this appreciation should appear in the valuation and the company be entitled to the benefit of it. It is in the nature of an increase of the investment, and should appear as capital.

It is clear that there are two classes of elements of value in the final value of a public service property: those which are physical, and those which are intangible. There are various of the physical elements of value which are not material or susceptible of inventory, but which, nevertheless, attach themselves to the physical property, are capable of determination, within reasonable limits of certainty, and should be taken into account and computed as physical property.

In the subsequent discussion of physical and intangible values, it is attempted to differentiate between such elements as should attach to the physical value, or capital remaining in the plant, and the purely intangible or franchise values.

It is contended by the writer:

That the Physical Value, or present value of the physical property, should fairly represent the actual capital invested in the property at the date of appraisal; that it should be made up of the sum of the various elements which constitute the cost of reproducing the property together with any appreciation which may have been added to any of them, less all depreciation.

That the Non-Physical Value is the difference between the "fair value" as defined by the Courts, or the reasonable value of the property as a business or producing property, and the physical value, or actual present worth; and that the only proper method for determining such values involves a study of income accounts.

This Non-Physical Value may be: positive, or a value in excess of the physical property, or negative, or less than the physical value. In the case of a property having a negative intangible value, a deduction should be made from the physical value.

It is further contended that, in making the physical appraisal, the purpose of the appraisal should not be permitted to modify the figures. The resultant figure should be the same, whether it is to be used as a basis for assessment, rate making, or limitation of capitalization. It should be an engineering estimate of the amount of *bona fide* capital still remaining in the property, or of the complete cost of reproduction under existing conditions, less depreciation. This figure is definite, within reasonable limits, and it cannot be conceded that it is permissible to vary it, submitting one result as a physical value for taxation, and another and different result as a present physical valuation for rate making.

There may be some question as to the propriety of using non-physical values for certain ultimate ends; in fact, the Supreme Court, in the Omaha and Knoxville water cases, clearly indicates that they must not be used for certain purposes; but, in any case, to furnish information, this element of value should be determined, and, as in the case of physical values, it should be an unchangeable figure and should represent the difference between the worth of the actual physical property and the final business value of the property considered as an earning proposition.

It is not necessary to go minutely into detail as to the various steps to be taken in making the appraisal of physical property. Each appraisal will offer some problems peculiar to itself, and no general set of rules can be laid down which will be applicable to all cases. It is deemed sufficient to call attention to general matters of major importance and to refer to some points which have not been mentioned in the preceding narrative, omitting argument in the case of such as have there been fully discussed.

The distinction should be kept in mind that any element of value which belongs to the property by reason of its physical existence is classed as an element of physical value. The property is considered as an operating property in the sense that it is reproduced complete, ready to operate; and any expense, or any element of value needed to complete it, is an element of the physical value, but any value arising as a result of surplus earning power, any good-will value, going-concern value, or value due to established business, strategic location, favorable traffic arrangements, etc., should be considered as intangible values.

The valuation of physical property is naturally divided into four parts:

I.—The preliminary study,
II.—The field inspection,
III.—The computation,
IV.—The preparation of the final figure

I.—The Preliminary Study.

The preliminary steps should include a general examination of the property, a study of its corporate history, an examination of its records, maps and profiles, and the preparation of an inventory of its property.

The work in Wisconsin and Minnesota was done in co-operation with the railroad companies, who prepared (generally, but not in every case) their own inventories on forms adopted by the appraiser. In Michigan, all this information was secured by the appraiser. There can certainly be no valid objection to the use of information compiled by the companies, whose familiarity with their own records and property would enable them to supply lists which under all ordinary conditions would be more complete and up-to-date than if made up by men having no special knowledge of the property.

The chief difficulty encountered in making an inventory from recorded data lies in the fact that very few sets of records are corrected to date, and many additions and erasures will of necessity have to be made in the field.

In making a field inspection, it is of great assistance to be able to refer to maps of large yards, to profiles, to standard plans, and to drawings of the principal structures, so that the investigation of office records should include a careful examination of the maps of principal terminals, with a view to securing such as will simplify the field inspection. The investigation should be extended to cover a study, not only of the engineering office data, but also statistical data to be derived from the records of the auditor, superintendent, and superintendent of motive power, and should cover earnings, operating expenses, car and locomotive mileage, and such other data as will facilitate the distribution of such elements of value as are not localized, together with such other statistics as will furnish a thorough knowledge of the property and its operations.

It has been claimed by the appraiser in Washington—and the view is also held by the Commissioner of Railroads in Nebraska—that original cost is essential, in view of the Supreme Court's decision, particularly in Smyth *vs.* Ames. The writer cannot accept the correctness of this position. It would appear that the language of the Court should be construed to mean that original cost, where ascertainable, is a proper matter to take into account, along with many other things, but it can hardly be considered mandatory.

In the case of a property only recently built, in which the records are complete and the engineering and construction files are available, it may not be specially difficult to determine cost, but in the case of any of the large railway systems of the United States, which are made up of the consolidation of many different roads, some of them built many years ago, some of them having gone through many changes of management, reorganization, and earlier consolidation, it is practically impossible to secure either the old financial books or the old construction records, and without these complete records it would appear to be an utter impossibility to secure the primary cost. Primary cost is but the first step. The work of building up, by securing the amount of additions and betterments that have been made from year to year, is one of appalling magnitude and of utter uncertainty and conjecture. Keeping in mind that, prior to July 1st, 1907, the railroad companies of the country did not have a system of uniform accounting, and that additions to property were charged to operating expenses to the extent of hundreds of millions of dollars; that policies were different on different roads, and under different managements of the same road, and that the accounting methods were determined by the policy of the road or management; and the further fact that the distribution of ordinary railroad accounts may be extremely reliable on one road and abounding with errors on another; it will be seen that any attempt to depend on the auditor's office for anything approximating a complete statement of cost would lead into a maze of figures which would be confusing, unreliable, and incapable of proof.

Therefore, it is the writer's conclusion that, beyond such figures on recent construction, or records of cost of such special structures as are matters of particular record, it is not advisable to attempt to secure complete data as to the cost to date of a railroad. In the Michigan appraisal, original cost was secured in the case of many structures, notably the Port Huron Tunnel, and it is by no means argued that original cost should not be considered, or investigated, but it is held that such an undertaking as to secure, from the financial books of the company, an accurate or reliable statement of construction cost, plus additions and betterments, less property destroyed, of the Michigan Central Railroad, for example, would be absolutely an impossibility, particularly if the work was to be undertaken, as in the Washington appraisal, by men who were utter strangers to the property. The admission of the appraiser of Washington, that, except for a few gaps, the information was complete, is fatal, as the gaps must needs be filled by estimates, and it would appear to be better to depend on estimated figures throughout than to use what purported to be actual costs on part and estimates on the remainder.

If original cost is essential, it is hard to get away from accepting the book values of the companies, as these, objectionable as they may be from the viewpoint of the public, are just as apt to be as near the actual truth as any statement made up by strangers from an examination of old records covering many years of operation.

II.—The Field Inspection.

The field inspection, to be of the greatest value, should be made by civil or mechanical engineers of long experience, preferably by men who have had charge of their respective departments on railroads of considerable extent, or of properties similar to that under investigation. The writer is of the opinion that in this particular phase of the work, the practice adopted in the Michigan appraisal was considerably in advance of more recent valuations. Each particular structure or piece of equipment should be examined and its condition noted; special features should be fully described and careful record made of everything that would tend to affect the value. The argument has been often made that the fixing of a percentage of depreciation by a man in the field is purely arbitrary and amounts to nothing but a guess. In the computing office it is often necessary to check the field figure of depreciation by the use of tables of fixed annual depreciation, but it must be borne in mind that mortality tables of any form are based on a system of averages. The actual depreciation on rail, for instance, varies greatly; the conditions of traffic, curvature, gradient, rolling stock, and various local conditions tend to shorten or lengthen the life, so that the personal opinion of an experienced man on the ground is likely to be much more nearly correct than the arbitrary application of a rule of averages.

The writer has inspected station buildings more than 50 years old, and their condition and adaptability for the service required of them would give them a very high percentage; he is also familiar with buildings less than 10 years old, which, by reason of changed traffic conditions and consequent shifting of business, have become obsolete and have been permitted to depreciate so rapidly that any table average would give too high a result.

In the case of a water-works inspection, so much of the value is included in the system of distribution mains, a form of property which is inaccessible, that much more dependence must be placed on a figure based on age; but there, also, as full investigation as possible should be made, in order to determine to what extent tuberculation or electrolysis has affected the pipes.

A general inspection (made in Minnesota by the appraiser with two assistants) would appear to be an excellent thing as a review of the whole work, but whether such an inspection would be sufficiently thorough to base thereon a set of final values, would appear to be doubtful.

The inspection in the field, in addition to the placing of a percentage for depreciation, should involve a complete check of the inventory, a correction of all errors, due to the construction of new property or the destruction or removal of old, and a compilation of all information required for a complete, correct, and intelligent appraisal of the physical property by the computing office. Every appraisal is different, and every property offers new problems and diverse conditions. These must be met, and therefore the field inspector must call particular attention to all matters specially affecting the values of the property he is inspecting.

It is impossible to anticipate all these conditions in advance, although the use of carefully prepared blanks and the standardizing of the form in which the data are gathered greatly simplify the work, not only in the office, but in the field.

III.—The Computation.

On the completion of the field work, with all the preliminary data in the office, the computation must proceed, and with this part of the work there are many questions which must be taken up, considered, and definitely answered.

The classification and arrangement of the information as to the property to be valued, the costs and prices of the various materials entering into construction, the making and checking of such tables as may be required for estimating, the computing, checking, filing, indexing, and the various other routine details of work need not be referred to specially, as they must be worked out for each appraisal. The matters of principle that will be met are more important, and, while it would be impossible to mention all that may come up, it may not be amiss to refer to a few.

(a) In making an appraisal of several properties, to what extent shall these properties be grouped or classified?

(b) What unit prices shall be assigned in the estimates of cost of reproduction, and how shall they be determined?

(c) How shall right-of-way and real estate values be ascertained? Shall such elements as appreciation, or any increments due to the purpose for which the land is used, be treated as physical or non-physical values?

(d) What method shall be finally adopted in determining depreciation? What elements shall depreciation be made to cover?

(e) What elements of cost or appreciation shall be treated as parts of the physical property although not capable of inventory, and what shall be treated as non-physical?

(f) Is an allowance for contingencies a proper item to include in an appraisal?

(g) What weight shall be given the matters of adaptability, proper or improper design, and the economics of location?

(h) How shall the values of such property as locomotives, cars, etc., be geographically assigned?

(i) What is the effect upon values of large terminals?

(j) Should an allowance be made by reason of rapid development of the art?

These are not by any means all the perplexing questions that arise; each valuation offers some that are special, but these cover the more important points.

(a) Classification of Properties.—In making an appraisal involving the properties of a large number of companies, such for instance as any of the State railroad appraisals, it becomes evident that there are certain properties which are small, badly run down, and either built to serve a very limited trade or located in a territory which has not developed, and that such properties cannot be compared equitably with the large trunk-line roads, or even with smaller roads in a good territory and doing a good business. Several such properties exist in Michigan in a district which was originally a lumber-producing country, and at the time they were built local conditions were such that prices of timber and labor were far below any cost that it would be reasonable to assume to-day. Whether taxation or rate-making be the ultimate end of the work, it is certain that these carriers are entitled to some classification which will separate them from the more prosperous roads. Many of these roads would not be built to-day under any circumstances, yet their maintenance and continued operation is absolutely essential to the people of the district served by them.

Whether this classification should be undertaken at the time of making the appraisal of physical property, and an attempt be made to classify unit prices, or whether this should be taken up in connection with the intangible values, and solved, as far as the valuation is concerned, by the adoption of such a method as will affect these physical values by a subtractive or negative non-physical value, or whether the entire matter should be left for the subsequent work of rate-making or assessment, is one which must be determined at the outset of the physical valuation. It may not be left without determination, as the question will be raised in all probability in the form of an attack on the valuation, if it is not considered and a conclusion reached.

It is the writer's opinion that the application of an intangible subtractive value is the proper solution, except in the case of roads which would not to-day be rebuilt. In fixing a uniform price for identically the same labor or material, whether on a small poverty-stricken road or a main trunk line, no serious injustice is done, provided the price fixed is one which, from a strictly engineering standpoint, is a reasonable figure for cost of reproduction. The differences in class are due, not to special differences in cost of physical property, but rather to differences in earning ability on account of good or poor territory served, efficient or inefficient management, or other reasons not connected with the physical structure; hence such differences are reflected in the earnings, and are clearly elements to be adjusted in the non-physical valuation.

(b) Unit Values.—The general reliability of the appraisal rests very largely on the reasonableness and fairness of the various prices which are applied to the different parts of the property in making the estimate of cost of reproduction. These unit prices should be determined before any actual figures are made. They should be made up from the most complete data available, and, before being tabulated, should be carefully reviewed by all the experienced men engaged on the appraisal, in order that no figure which is either too high or too low may be used.

As a basis, the average of either 5 or 10 years should be used in preference to current prices on all such material and equipment as is fairly stable. Rail, and all forms of rail structures, machinery, locomotives, cars, etc., can be reduced to such a unit that averages can be secured which will eliminate the error due to a period of extreme high or low prices.

In the case of such materials as lumber and ties, the price of which has been steadily rising due to the growing scarcity of the material, a price based upon a long average is unfair to the corporation, and it would appear to be proper to use current prices. There can be no hard-and-fast rule which will be applicable to all appraisals. The unit prices must be such reasonable figures as can be sustained in Court. Their adoption should not be final until every possible test of their accuracy and reasonableness has been made. When they have been adopted, and such modification made as may be fair for certain territory on account of local conditions, transportation facilities, or other consideration which may affect them, the adopted figures should be applied to all property alike. The use of different unit figures for different roads in the same territory is highly undesirable, and should be avoided.

(*c*) *Right of Way and Real Estate.*—The valuation work which has been accomplished during the past decade, and the study of values for taxation and rate making, have brought into prominence the perplexing features of land values as applied to corporation property. It is comparatively simple to fix within very close limits the reproduction cost of tracks, bridges, locomotives, or any of the other elements of physical structure. Not so with the land. A few years' development may change farm land right of way into city right of way, surrounded by factories, or it may change desirable residential property adjacent to a road into slums.

In view of the clear language of the Court in 82 Fed., 839, and 157 Fed., 849, it is evident that any valuation which does not take into account the appreciation or depreciation of land values cannot be sustained. There can be no serious objection to the doctrine that the property of a corporation generally increases or decreases in value in the same proportion as adjacent property, and it must therefore be admitted that a value based on the sale value of adjacent lands is a reasonable one and must stand. This reasoning, of course, will be subject to exceptions, in the case of terminal properties, docks and water-front properties, and right of way in large cities, but it is believed to be sound when applied to right of way in the country and in small towns and cities.

The next question to be determined is whether the increment of value due to the use of the land is a proper one. It would appear that in the use of land for water-works, gas-works, street-car barns, or other isolated tracts of land used for corporation purposes, this increment would be much less than in the case of a steam or interurban railroad, the holdings of which form a continuous and unbroken strip; and, in the case of street railroads, water-works, and like properties, it would be indeed difficult to compute and afterward sustain any considerable increment.

In the case of railway properties, however, it is quite evident that the following facts can be sustained: The actual cost of property purchased for railway purposes will range from two and one-half to five times the selling price of similar and adjacent property used for other purposes. While the actual percentage will vary somewhat, as between land in cities and in the country, and as between fully settled districts well served by roads and sparsely populated regions, yet the difference is very marked, and is capable of determination by an examination of the public records.

This difference can be determined either by a comparison of railway purchases and other transfers, as was done in the later studies in Michigan and in Wisconsin, or by extending the investigation to include assessed valuations, and using the averages, as was done in the work of Mr. Morgan in Minnesota.

In establishing figures for use in a valuation, it would appear to be better to base them on an analysis of actual transfers than to undertake to fix values by any methods of examination and personal appraisal. Enough instances of the wide divergence of expert opinion have been cited to show conclusively that such a method, applied to the thousands of acres of a large corporation, may lead to serious error.

A single attorney or real estate man who has had experience in abstracting and conveyancing, and who has bought some right of way, can examine the records of an average county the largest city in which has a population of 20 000 or less, abstract all railway transfers for 5 years, locate them on the maps, secure data as to actual selling prices of near-by lands, and, in a comparatively short time, be in position to furnish figures which will establish the relation between sales for railway and other purposes in that county. The work that half a dozen such men could do in 90 days would go very far toward establishing with a fair degree of definiteness the value of the railway purpose increment for the majority of counties in any average State. Of course, such an investigation in the large cities is a matter of much greater labor, and would require sufficient time to make complete examinations, probably necessitating a special force for such city work.

On every appraisal, the question has been asked, should this railway purpose increment be added to the value of the property? Clearly, yes.

The Supreme Court quotes approvingly from the Tennessee Court, as follows (151 U. S., 479):

"The value of the land depends largely upon the use to which it is put and the character of the improvements upon it."

This is stated again and again. It must be remembered that, for railroad uses, the strip must be continuous; that it must be located so as to permit curves and grades which conform to the requirements of the road; that, no matter what damages may accrue to adjacent property, the road must take its strip; that its use is entirely changed and is a structure placed on it which is capable of vastly greater earnings than the property produced before—all these elements add to the cost of the property when it is acquired for railway purposes, and in the same measure to its value under its new use.

In a new country, where transportation facilities are limited and land cheap, this added increment may be little or nothing, but in a thickly settled State, with many railroads, this element will increase with a good degree of uniformity; while, in terminals, the price rises to almost inconceivable figures. It is capable of being determined, and is clearly an element in the cost of reproduction. The writer holds to the view that it is properly to be placed with the physical values and that it should not be considered as an intangible element of value.

(*d*) *Depreciation.*—Thus far, this discussion has not dealt at length with the subject of depreciation, and it is not considered essential to the purposes of this paper that it be done. The State appraisals have raised a question as to the propriety of using mortality or life tables as compared with personal inspection and the placing of a percentage based on individual judgment. Either method is subject to error. It is certainly desirable to secure the opinion of the man who inspects a bridge, or building, or locomotive, as to its physical condition. It may be desirable to use the check secured by the fact that the age of the building is known and also the average life of structures of its class.

The result of the Michigan inspection of rolling stock was to sustain fully the rules for valuation issued by the Master Car Builders Association; and clearly, it is not only proper, but extremely desirable, to apply tables to such equipment as freight cars, which are scattered all over the United States, for it would be absolutely impossible to inspect completely those of any road or system. On the other hand, the life of steel rails cannot be determined by any simple table, because the number of car movements, the weight of motive power, the speed of trains, the location (on curves or on heavy grades), and many other conditions affect their life. This also pertains to buildings, locomotives, and other equipment. The character of service rendered, the nature and extent of repairs, and the way in which they have been maintained, add to or take away from any life assigned by tables, so as to render them valueless in many individual instances.

In placing depreciation, allowance should be made, not only for wear and tear due to use, and decay due to the elements, but also to cover that which is due to obsolescence, or the fact that the facility is of an antiquated or inefficient type, and has been superseded in general use by more efficient and economical devices; this may be called commercial depreciation, as distinguished from physical depreciation. The method to be used in placing depreciation is clearly one of the important things that must be determined by each set of appraisers, and, while the writer believes that the use of expectancy tables would greatly facilitate the work in many cases, the data on which to found a complete set of tables and to support them and justify their use are often lacking; therefore, any use of tables should be safeguarded in every possible manner, and personal inspection of fixed property should always be made.

(*e*) *Immaterial Elements of Physical Property.*—There are certain expenses, inseparable from the construction of any public works, which are a necessary and proper part of the cost, and are arranged for in the original financing, but are not capable of identification after the completion of construction work. These expenses are:

(1) Organization,
(2) Legal expenses,
(3) Engineering,
(4) Administration,
(5) General expense.

(1) Organization.—This includes the cost of the original organization of the company, the cost of securing the charter and franchises, arranging the financial plan, and securing the funds for construction.

The latter item is intended to include all salaries and expenses of officials in soliciting and negotiating for funds, the services of trustees, and all other proper expenses which are usual and unavoidable in the process of exploiting a projected enterprise and interesting capital therein. Discount on bonds is not included, and any allowances for "premium," or "bonus," or other cash payment to any party for services in securing funds, which are in excess of legitimate expenses, should receive scant consideration at the hands of appraisers.

(2) Legal Expense.—This is for attorneys and all legal expenses, costs, and fees in the organization and during the construction of the property.

(3) Engineering.—This includes reconnaissance, preliminary and location surveys, supervision of construction, and design and superintendence of special structures. The cost of engineering on some of the more difficult properties becomes a very large sum, on certain small lines it may be comparatively small, and in some cases no engineers have been employed at all; but the items of cost covered by this charge have in every case been expended, even if done under the direction of some superintendent.

(4) Administration.—This comprises the cost of the management during construction—the direction of the enterprise.

(5) General Expense.—This is the cost of the general office organization during the construction period, also numerous minor expenses, not distributable.

It is not possible to build any public service plant without incurring all these expenses to a greater or less degree. They are essential elements of cost, and must go into the value of the plant when completed. It can hardly be argued that cost, which in a large property runs into thousands or hundreds of thousands of dollars, has no value at the commencement of operation, nor does it appear that the value is subject to depreciation as long as the property is an operating plant. The writer holds the view that the line between physical and non-physical elements of value should be drawn as follows:

Any value which attaches to the property by reason of any money expended during the construction is part of the physical property values; while any value due to the operation of the property which is in excess of the physical value is a non-physical or intangible element. If the correctness of this position be conceded, then all the foregoing items are charges against the physical property, and, as long as it is an operating property, these items of value remain part of the physical property, and the writer contends that they should not be considered as affected by depreciation, as long as the property is a going concern.

Different engineers have included in the appraisal other items which are of a somewhat different nature, and some of which are open to argument; among these are "interest during construction." This item is clearly an allowable one, but serious differences of opinion develop as to a proper amount to allow in making an appraisal.

The corporate history of the Ann Arbor Railroad, in Michigan, shows that it was built in sections of from 25 to 30 miles, and that each section was put into operation as soon as built, so that, while the actual period of construction of the complete property extended over 15 years, no section was under construction much more than one year. This is typical of much of the railroad building of the past, and on such a property the interest charge would be comparatively small.

A proper charge in such a case would clearly not be sufficient in the case of a road several hundred miles in length, through mountains, with tunnels, heavy bridges, and other structures which would extend the actual construction over periods of from 3 to 5 or 6 years, and this is particularly true where the road is a main line or artery, and where local traffic is of minor importance.

The computation of the interest charge is complicated by the fact that interest begins to run as the bonds are taken up, and but a small part of the construction money draws interest during the whole period.

The practice in the State appraisals has been to fix a uniform percentage for all properties. This has had in its favor the argument that it was conservative valuation where taxation is the ultimate end, as the amount was less than one year's interest in every case. It would appear to be more correct to use the corporate history of each company, determine the actual construction periods, and use a rate based on the actual time in each case. This can be fixed with a fair degree of accuracy, and a reasonable percentage determined, to equalize the varying periods of time on which the interest runs on different parts of construction.

Discount.—Discount on bonds is claimed by certain railroad men as a proper item for consideration. As has been argued elsewhere, this is not a proper charge against capital. It is an adjustment of the interest rate to the market, or an advance payment of interest; and, in the writer's opinion, should under no consideration be allowed.

Working Capital.—Working capital is another item claimed and conceded in some valuations. It is not a part of the "cost of construction." The money provided for working capital at the outset is not a permanent investment, but is rather a temporary loan paid back out of earnings. The writer fails to perceive any possible argument in favor of adding such an item to the permanent value of the property. In making an appraisal, after the physical value is determined, it is usual to set up a statement of stores, supplies, fuel, and cash on hand, and working capital is certainly shown by the current balance sheet, in the form of cash or accounts receivable. It would appear to have no place in a physical appraisal. Although the items of cash, stores, and supplies were shown in the Michigan appraisal, they did not appear as part of the physical value, nor were they taken into account in computing intangible value, but, being taxable property, they were reported separately.

(*f*) *Contingencies.*—The use of a percentage for contingencies in the appraisal in Michigan was bitterly contested by the railroads as improper and excessive. In Michigan 10% was used, in Wisconsin 5½%, and in Minnesota 5 per cent.

Subsequent work in Michigan has demonstrated that the use of as high a figure as 10% was fully justified; and the probability is that the latest Michigan appraisal did not eliminate omissions, inaccuracies of description, and excess cost of construction due to difficulties, to such an extent as to justify much reduction in the percentage.

In making an appraisal, the percentage to be applied to cover contingencies is a proper matter for consideration, and in some cases conditions might well be such that even a smaller allowance than that fixed in Minnesota would be proper, but such cases would doubtless be the exception. The writer believes it to be proper practice to add liberally for the contingency item. The strongest argument against it is that it is incapable of being described and located definitely, and is difficult of exact proof. Therefore it has been claimed that it partakes of the nature of a non-physical element, and that if there be any value over and above the physical property value, it will appear with other non-physical elements reflected in the earnings, and may be properly included in the intangible value if such exists. This argument does not appeal to the writer as being final, and he would advocate the use of such a percentage of physical values as appears proper in each appraisal to cover the error due to the extreme difficulty of securing an exact inventory and construction history of the properties.

(*g*) *Design.*—Among the matters which were considered in the Michigan work was that of adaptability, or the economical questions of location, design, and construction. It is possible that in some properties, such as water, gas or electric companies, the efficiency of the plant may be very greatly affected by faulty design, uneconomical arrangement, improper construction, and to such an extent that any cost of reproduction, less any ordinary depreciation, would be greatly in error without further allowance. This may also be true of railroads. Excessive curvature and gradients greatly decrease the tonnage hauled by a given power, without decreasing the cost per train-mile.

It is extremely difficult to treat this as a physical element. It is impossible to reduce it to terms of dollars and cents by any usual or customary methods. It is impossible to separate it from any one of half a dozen other items that may be brought up. It opens the door to endless speculation as to what might or might not take place under somewhat different conditions. For these reasons, it was treated in the Michigan appraisal as a non-physical element of value and dismissed from all consideration in the physical appraisal. This was clearly proper, and the subject is only referred to here for the purpose of making clear that it was fully studied and a definite conclusion reached.

Adaptation.—In the sense that this term is used by Mr. Williams and Mr. Morgan, the appreciation or solidification of roadbed was considered in the Michigan work, but given no place in the appraisal. This is a very proper item to consider, but it would appear to be better to include it directly with the roadbed item in the physical appraisal as appreciation or solidification. There can be no reasonable objection to adding to the contract prices for grading, ballasting, etc., a reasonable amount to cover, not so much the seasoning and settling of the new roadbed, as the actual money disbursed in work on this new roadbed during the first 3 or 4 years of operation in order to bring it up to the proper operating condition. A very considerable part of the money spent on "maintenance of track" for the first few years after a new line is built is in reality deferred construction cost.

(*h*) *Apportionment of Values.*—The apportionment of values of locomotives, cars, miscellaneous equipment, shops, and those other parts of the cost which are not susceptible of separation from the operation of the property as a whole, is an interesting and at times a perplexing problem. While the Courts have viewed as equitable the distribution of values between territorial units when made on a track-mileage basis, it is hardly likely that a Court would look with favor on an appraiser appointed by Michigan giving any consideration to values of bridges, track, or buildings in Ohio. Thus far, every State appraiser has concerned himself only with the fixed physical property in his own State, together with his proportionate share of the floating property. The methods that may be considered are track-mileage, car-mileage, locomotive-mileage, and train-mileage.

The method finally used must be such as will give the fairest result for the property under consideration. In some cases one or more of these methods will give a fair value, while in other cases the same system would be most unjust.

(*i*) *Terminals.*—There is no one feature of the entire problem so big with possibilities, and so far from solution, as that of terminal property values and their proper assignment. The property must be considered as an operating unit. Its value must be made up of the values of the parts or elements plus an added value that comes from the operation of the whole. The problem would be simplified if what were sought were the value of a certain railroad, but, as it has been presented up to this time, the problem is: what is the value of that part of this railroad in Michigan? or Wisconsin? or Minnesota? A fairly satisfactory solution of many of the value questions has been obtained, but nothing in the way of a solution of the terminal question. A road owns 300 miles of line in Michigan and 7 miles in Ohio. That 7 miles includes its largest terminal; its principal connections are there; it has a fine property, and is in the capacity of landlord to several other roads. What part of that terminal value, if any, is assignable to the State of Michigan? Decidedly, it would not be proper to appraise the entire property as a unit and assign to Ohio only the proportion that 7 miles bears to the whole length; it is equally unfair to appraise it as a Michigan property down to the State line, and add nothing to the value by reason of the terminal.

The influence on the value of the property, of the ownership of terminals in such cities as Chicago, New York, Jersey City, Hoboken, Pittsburg, Detroit, St. Louis, Kansas City, and other large centers of population is tremendous, yet a very large part of the railroad mileage entering those cities belongs to roads which have their largest mileage outside the State in which the terminal is located.

There can be no doubt that the influence of a large terminal affects in a measure the value of every mile of line owned by the company; that this influence is greatest on the principal and direct lines, and less as more remote parts of the system are reached. As yet, no plan has been suggested for determining what this value is or for apportioning it.

The final solution in Michigan was to treat terminal properties within the State exactly as other property was treated, and to assume that, if there was any value assignable to Michigan by reason of outside terminals, it would appear as a non-physical value through the earnings.

When all the phases of this question are considered—the enormous land values, the value due to possession of deep-water terminals, the effect on the business of the entire property by reason of the ownership of such properties as those, for instance, in New York City, Jersey City, and Hoboken—it is evident that no appraisal which has yet been made has established any rule of valuation which may be considered proper for terminals.

It is to be hoped that the work now in progress in New Jersey may be so well supported by the State that it will be possible for the appraisal board to make an exhaustive study of this subject and reach definite conclusions as to the real extent, manner of computation, and proper method of distribution of these values.

(*j*) *Development of the Art.*—Is any value assignable to property on account of expenditures by reason of the rapid development of the art? This question seems not to have been squarely asked or answered in connection with any of the past appraisals.

Every piece of material and every facility purchased by a company is bought with a definite expectation that it will have a certain life, that during that term of life it will add sufficiently to the earnings to provide a fund for its replacement and earn a profit. No matter whether or not such a reserve is created on the books, this is the theory, and, under it, accident may wipe out certain new property, other property will outlive its expectation and maintain the average life of the entire group of facilities.

There are countless cases where this will not hold. The rapid development of large cities has compelled electric lines to extend largely. The demands of the people for more frequent and more rapid service, and more modern and larger equipment, have greatly shortened the term of life of power-plant equipment and cars. The rapid development in the art of electricity, the congestion of traffic in streets of cities, the enormous increase of train movements, and the use elsewhere of newer types of cars, have compelled the abandonment of millions of dollars' worth of property and the investment of other millions in new and improved facilities to provide for the increased movements of traffic and increased safety to the public. These changes are not due to the fact that the original installation was defective, but to the demands of the public for frequent, safe, and speedy service, demands which are perfectly reasonable. The query is: should a corporation which complies with public demands be compelled to lose capital invested in facilities which have not yet paid for themselves; and which, under a continuance of conditions which existed when they were installed, or any that might then have been anticipated, would normally have a useful life of several more years, and which were abandoned, not by reason of being worn out or unfit for service, but purely because facilities of a more modern type were called for?

To answer this affirmatively increases the hazard of investment greatly in the large centers of population. To answer it affirmatively in some cases might amount to confiscation of property. The writer inclines to the view that, as far as appraisal is concerned, the value due to the remaining life of the abandoned facility, where such abandonment was in response to legal requirement, and where no element of corporate necessity due to increased efficiency or economy of the new facility enters into the computation, should be added to the value of the facility replacing it. Any consideration that is given such claims by an appraiser must be most careful, as the inference to be drawn from the decision of the Court in the Knoxville Water Case (212 U. S., 1) is that such elements of value will receive scant consideration unless most fully supported.

If the policy of the management of any public service company is to keep up with the demands of modern civilization, it would appear that such policy should not be discouraged, and, in computing the value of the property, some provision ought to be devised for covering such values as remain in serviceable property at the time of its abandonment in response to public demand; or else the rates for service should be increased sufficiently to compensate the corporation for losses of this nature on the ground that it constitutes an element of extra hazard.

These and like subjects in connection with the appraisal must be taken up during the period of computation and settled. The computing office organization and methods call for no special comment, except to emphasize the need of experienced men, the use of every possible check on the accuracy of the work, and the prime necessity of keeping all notes in such manner that they can be identified and used to re-establish every step taken in the course of the appraisal.

IV.—The Preparation of the Final Figure.

The final form of the work is, of course, so much a matter of personal judgment that even a suggestion may appear to be useless. The use of such a classification as will conform approximately, if not exactly, with that adopted by the Interstate Commerce Commission is more desirable now than it was 10 years ago, as all the roads in the country are using this classification in their accounts, and the more nearly uniform the work of various State appraisals, the better the results will be.

NON-PHYSICAL VALUES AND METHODS FOR THEIR DETERMINATION.

In the published articles treating on the subject of valuation, much stress is laid on the intangible or non-physical elements of value. They have been termed "going concern values," "business values," "good will values," "franchise values," as well as "non-physical" and "intangible" values.

So much of the argument of many writers has been taken up with this phase of the question that it is impracticable to recapitulate the various arguments in support of giving these elements a place in the appraisal.

The writer cannot agree with those who would place any of these elements of value in the physical appraisal.

Value is given to a property, either by reason of the fact that it is an instrument for earning profit, or that it does earn profit or gives promise of profit. The actual investment of capital in a new plant is made with the expectation of earnings. It is not reasonable to attach as physical value, to such a plant, any value in excess of the actual investment. Nor does it appear to be any more reasonable, in the case of an old plant, to assign arbitrary and fictitious values over and above the actual investment remaining in the plant, unless such values are justified and supported by actual earnings in excess of such a rate of interest on the money invested, as it would earn if invested in some non-hazardous security, and—carrying out the clearly-expressed idea of the Courts—such intangible value can only accrue when the rates charged for the service are fair and proper.

The capitalist seeking investment bases his ideas of value on:

(*a*) The market price of stocks and bonds, an estimate of worth based primarily on actual earnings of the property, but affected to some extent by outside conditions; or

(*b*) On the capitalized net income, or actual earnings, of the property; or,

(*c*) In the case of a new property, on an estimate of what the probable earning capacity of the property will be, where the business is more fully developed.

Methods (*a*) and (*b*) ignore cost of construction, or present investment in physical property, and base a value on past performances. Method (*c*) is based purely on hypothetical earnings, but the only real measure of value in this instance is the actual amount of capital that has been invested.

No appraiser would be justified in placing a "going concern" value, in excess of original cost, on a new property, nor would he be justified in placing such a value on a property 3 years old, or 10 years old, unless the net earnings were such as to indicate that the property had a business or commercial value in excess of the physical property value.

It would seem reasonable to say that this difference between the physical value and the value based on earnings represents the "good will," "established business," or "going value," and all the other non-physical elements of value.

To take a specific example: it would be impossible to separate the different elements of intangible value of the Michigan Central Railroad, and say that a certain sum of money represented "good will," another sum "established business," still another sum the "franchise value," and still another sum the "going concern."

The "going concern value" of the Michigan Central Railroad is exactly analogous to the going concern value of the hypothetical water-works cited by Mr. Alvord. Instead of having water pipes connected with buildings along the mains, and considerable sums invested in appliances for using the water, there are manufacturing plants located along the railroad, connected with it by side-tracks built by the industry, and depending on the transportation facilities of the road for their connections with their customers, the very life of the manufacturing plant dependent on its connection with the road. This is "connected good will" of the same kind as described by Mr. Alvord. Yet, to fix a value on it by the method described by him involves going into the realm of conjecture and speculation to a degree that could never be sustained.

Difficulties as great would be encountered in an effort to separate and set up any other elements which go to make up the intangible value, and any figure thus determined would be absolutely incapable of proof.

The Courts say that the value must be the "fair value of the property being used," all the conditions being taken into account (169 U. S., 466).

It can be readily seen that the physical present value is not always —indeed, is not often—the "fair value." The "fair value" may be more, or less, than the present value of the physical property. It would seem to be reasonable to interpret the Court's meaning of the term "fair value" to be the value as a business or commercial property, taking into account the actual investment existing in the property, together with any favorable conditions which would enable it to earn, on rates which were fair and reasonable to the consumer, an income in excess of a usual rate of interest on the actual investment, or any unfavorable ones which under the same rates would reduce its earnings to less than usual interest. If such an interpretation be allowable, it would appear to be correct practice to use a "fair value" made up of two elements: a physical value, representing the investment, and a non-physical value, representing all the elements which affect that investment to give it favorable or unfavorable financial returns. Is it not, then, proper to conclude that the non-physical or intangible value, composed of all these various elements of value, can only be determined absolutely by a study of the earnings and operating expenses? Is not this clearly what the Court had in mind in the Nebraska Rate Case?

Much of the argument on the subject of "going" values and other kindred elements of value consists of statements of theory and generalities, and may be said to be merely argument to support the theory that there is an intangible element of value. If work of valuation is to be of any real benefit, must it not give a definite result? Must not this result be based on absolute facts?

In securing the present value of any physical property the fixed and certain facts are:

The inventory of property owned.—This is absolute.

The cost of reproduction of the different elements.—This is capable of determination within very close limits.

The depreciation.—This is in a measure a matter of judgment, based on the experience, not only of the engineers making the appraisal, but of the entire scientific world; and, if properly made and properly checked, there should be no very wide divergencies in results.

The items of general expense.—These, based on available statistics, must be estimated. The exact determination of these items will be made comparatively easy as statistics based on the uniform classification of accounts become available.

It is believed that the physical values, when secured along the lines suggested, are definite enough to be accepted as a fair estimate of the amount of capital actually invested in the property, and that, if a sufficiently large force of men experienced in the construction, operation, and financial management of the kind of property under investigation is engaged on the work, the element of uncertainty due to errors of personal judgment can be largely eliminated.

The next question to be determined is whether there is, at the time of the appraisal, any non-physical value, and, if so, to select a method for computing it that will give a result that can be definitely supported as to the particular property under investigation. A study of the income accounts of the property being valued should be made. If the property is not earning a sufficient sum to pay its operating expenses, and taxes, and to set aside a fund to cover depreciation and obsolescence, there is clearly no intangible value of any sort to be added to the physical value. If, however, after all these charges are taken care of, there is a net earning which is large enough to pay 4 or 5% on the physical property and still leave a surplus, is it not perfectly reasonable and proper to hold that this surplus represents earnings on all intangible elements of value?

The contention that all the different elements of non-physical value merge into one intangible value, not capable of separation, will doubtless be objected to by many engineers and corporation managers.

Among the elements adding value to property have been described:

1.—"Going Concern" Value.—Professor Mead defines this as the value due to the fact that a plant has consumers actually utilizing its product, and that it is in actual and successful operation and has its business developed. This value is the worth of the plant in excess of a similar plant without connections, and constitutes an asset in the consideration of its physical value. Mr. Alvord has used the term "connected good will" as applicable to this element of value.

The writer does not concede that "going concern" is a proper element to consider in the physical value, as it does not represent any part of the cost chargeable to capital, and the physical valuation should be confined to the determination of capital invested.

It has already been argued that to the physical property as inventoried should be added proper figures to cover organization, legal expense, administration, engineering, and contingencies. All these items are in the nature of additions on account of the fact that the property is a "going concern." It is maintained that these costs should carry to the present value column as values, for the reason that all these services rendered in connection with the creation of the property remain, unimpaired in value, as long as the property is operated. When, however, a property ceases to be operated, and is abandoned and dismantled, not only do all these elements absolutely disappear, but also all increments of value by reason of the special use of the property are wiped out, and there exist only a lot of partly worn out and partly obsolete machinery and equipment, salable at scrap values, buildings constructed for a purpose which renders them unfit for other use, and land partly salable at going prices and much that will not sell at all.

As long as a gas-works, a water-works, or a railroad is in operation and earning, it is a "going concern," and all increments which attach to its physical property as a whole continue to exist, even if the physical value of the property is greater than a fair value. That fair value can be determined and reached by means of a negative non-physical value.

In view of these things, it would seem to be highly improper to add to physical value anything more for "going concern." In the final report of U. S. Judge R. W. Tayler, Arbitrator in the Cleveland Street Railway matter, in December, 1909, the following language supports the above contention:

> "I allow nothing for going value, except in so far as that is the result of the necessary expenditure of money in building the road, acquiring its land, power-houses, and equipment, and putting them into successful operation. The expenditures for these purposes are, and necessarily must be, included in the valuation of the physical property."

2.—Developed Business.—It is perfectly clear that the "fair value" of a property must take into account the established business of the concern. This really is covered by the "going concern values," as defined by Messrs. Mead and Alvord. The only manner in which this can be determined intelligently is by an analysis of income accounts.

3.—Cost of Handling Business.—A railroad with heavy grades, bad curves, poor equipment, or unskilful management is not nearly as valuable a property as one having good line and grades and far-sighted, economical, and skilful management and which handles its business at a lower cost per unit.

In such cases the differences in location and management are bound to show in the earnings, adding to the physical value of one property and possibly taking from the value as shown by the physical appraisal in the case of another.

4.—Good Will and Established Organization.—These are valuable assets. It is difficult, indeed, to attach exact weight to these elements of value, except as they are shown in the intangible value indicated by the earnings. In most cases of public service companies, as is argued elsewhere, it is doubtful if such elements are entitled to any place in a public valuation.

5.—Franchise Values.—These cover various specific items arising out of the ownership of special franchises, or, out of the general rights granted by law to corporations.

All these elements of value have been presented, and have been supported by able arguments. No one has offered a method of separating them. While there is universal recognition of their existence, in the case of many properties, they are supported by nothing visible or tangible. They are practically inseparable, one from another. They are not always present, and the application of any such arbitrary rule as that suggested by Mr. Alvord would make it possible to place values which were purely fictitious. Therefore, it follows that, if they are to be considered at all, they must be treated as parts of one intangible value, and that value must be derived from a study of the income account of the property.

There are other points to be noted as reasons why no such elements of value may attach to the physical property.

Any value of an old and well-established property in excess of a fair return on its physical property (in other words, any intangible value) must be limited and restricted, when used for rate-making purposes, by the value to the consumer of the services rendered. The Courts hold so squarely that the rates charged for services must not be more than the particular service is worth, and that the Company may exact a fair return on property actually being used, that it is not conceivable that any valuation which attempts to attach fictitious elements of value to physical property can be sustained.

This argument is not intended as an attempt to show that intangible values are improper and that where they exist rates should be lowered. It is contended that the determination of rates that will be just and fair to all competing companies involves other consideration than the valuation of either physical or intangible properties, and that when all these rate-making problems are properly solved, there will remain large intangible values on the well-designed plants. It is further contended that the work of valuation should separate the tangible and intangible elements, so that the further work of rate-making or assessment may not be complicated by improper elements which are included among the items of the physical properties.

In consideration of franchise value, the history of the corporation should be investigated with a view to determine what part the public played in the creation of the property.

The granting of aid bonds, of public lands, and of aid money to railroads, the giving of encouragement to water-works companies by the payment of excessive hydrant rentals, are illustrations of the fostering and development of public service utilities by the public to such an extent as to justify in a large measure the claim that in many cases the allowance of an intangible value is improper as against the public.

A further consideration in the matter of intangible values is the fact that they all partake more or less of the nature of "good will," and the question very properly arises, in the case of a purchase by the public, or of a rate-making valuation: "Should the public be compelled to pay for its own good will?" In the case of such a corporation as a street railway company in a large city, any value arising from a surplus of earnings is due to the franchise, established business, or going value, or good will of the citizens of that city. This element of value frequently sustains an excessive bond indebtedness. At the expiration of the franchise period the citizens of that city consider a purchase, and are asked to pay, among other things, for their own good will. In view of the attitude of the Federal Courts in the Consolidated Gas Case, and the language of the lower Court in disallowing the item of "good will," which judgment was sustained by the Supreme Court, it is very evident that any attempt to fix arbitrarily a value on such an item in an appraisal is not likely to be supported successfully. The grounds named by the Court are:

> Tangible property has a value apart from any franchise or good will value.
>
> The franchise, conferring the privilege to be a corporation, to use public property, to be free from competition, and to enjoy many other privileges, has some value apart from tangible property.
>
> Good will can have no existence as apart from or detached from the franchise conferring the necessary privilege. Such good will (by itself) is not capable of being capitalized and distributed among stockholders.

> Citizens are entitled to have gas (or water) because they pay for it, exactly as they are entitled to have clean streets (and, in the same way, police protection or fire protection), because they pay taxes among other things for that.

The Court, therefore, finds that there is no good will value in connection with the gas business in the City of New York, although it is said, elsewhere in the finding, that it is the best, most favorably located, and most prosperous business of its kind in the country.

Judge Tayler, in the Cleveland Railway arbitration, says:

"I allow nothing for good will. A street railway company which has a monopoly, and especially if it has a franchise value remaining, can have no good will value."

Judge Lurton, in the Omaha Water-Works Case, says:

"That kind of good will, as suggested in Willcox *vs.* Consolidated Gas Co., is of little or no commercial value when the business is, as here, a natural monopoly with which he must deal, whether he will or no."

In connection with a consideration of franchise values, the following points are raised by the Federal Court in the Consolidated Gas Cases (157 Fed., 872-879):

"Should a corporation have a right to demand an income return, separable from any return upon its tangible property, from its right to place gas mains in the public streets and maintain them for its private profit, a right which it did not buy from city or state or pay therefor any legal valuable consideration? The Court thinks not, because 'Return can be expected only from investment, and he that invests must part with something in the act of investing.' Does any company invest its franchise in its business? It does not part with its franchise in the same way it parted with money or money's worth in acquiring or creating mains or plants. The investment of property was made, not in the franchise, but under the franchise, and on the faith thereof. The franchise is but a part of the power or sovereignty, allotted to a private person for the benefit of all, and only incidentally given for private emoluments.

"What is the value of a franchise to perform a certain service, under which no money is invested and no service yet performed? What is it worth apart from performance under it?

"Unless it can be seen to possess inherent value entirely apart from the earning capacity of the subsequent investment or from the actual earnings resulting from such investment, the value asserted or claimed is but a duplication of that derived from the use of the tangible property when so invested.

"The concepts of the nature and value of franchises are seen dimly and confusedly because of the failure to distinguish between productive and non-productive property. Land, money, chattels may by industry and intelligence be made productive without a franchise; but no excellence in these desirable qualities can ultimately render a franchise productive without the use of money, chattels, and land in connection therewith, and when the juncture is made the earning capacity of the real and personal property, plus the franchise and plus intelligence and industry, is really no greater than it would be without the franchise, for the franchise has added no producing power to the realty or personalty; it has but authorized their employment in a particular way and protected the owners while so employing them."

The Court emphasized the fact that the particular way in which they are used is in performing a function of the State—in doing a service for the public which the public might do equally well for itself, in the following language:

"I can imagine no more than three ways in which the value of a franchise can be stated. It is valuable: (1) because it authorizes the gainful use of private property in a particular manner; (2) because once obtained it is often difficult or impossible to get another like it; (3) because it may be used to injure or hinder another enterprise, although itself conferring or securing nothing of value.

"The third method of statement has been accurately, though colloquially, described as a "nuisance value," and is so obviously illegitimate as to require no discussion. The second method of statement, when carefully considered, asserts that because the sovereign has deemed it advisable to entrust a public work to one citizen or a body of citizens such quasi monopolistic grant confers the right to charge for the service more than would be just or lawful were the occupation open to all. Nor does it change the truth of the last statement that the difficulty of procuring franchises produces, and long has produced, a traffic in them. On every private sale of franchise property, the price paid is so much money lost to the public by official incompetence or worse, and such sale can confer on the vendee no right to compel the consumer to repay him a price that should have been paid to the State. For these reasons, I believe that on principle a franchise should be held to have no value except that arising from its use as a shield to protect those investing their property on the faith thereof, and that, it renders fruitful, it possesses no more economic value for the investor than does an actual shield possess fighting value, apart from the soldier who bears it."

It will not do to leave this decision without calling attention to the fact that the foregoing quotations are but argument advanced by the Court, and that he found a franchise value, following the reasoning of the Supreme Court in cases cited heretofore, and other cases, and upon the doctrine that:

"Private citizens may acquire vested property rights through a series of even erroneous decisions; rights so firmly vested that it becomes unconstitutional for the court which persisted in error suddenly to rectify its mistakes to the detriment of those who had securely rested upon the decisions sought to be invalidated."

After citing numerous cases and considering methods of valuing franchises, the Court says:

"I think it obvious, as I have endeavored heretofore to point out, that either for the purpose of condemnation or regulation the value of a franchise depends wholly upon what is earned under it and I believe the best way of finding out how much a franchise, separately considered, is worth, is to ascertain what those persons desirous of continuing operation under it consider it to be worth. In a corporation whose stock is freely bought and sold, such value is measured by the success attending the sale of stock based entirely upon capitalization of the franchise; yet the value of stock issued only in consideration of the franchise is obviously dependent on earnings after the stock based on tangible property has received a satisfactory dividend * * * yet it will always be true that, unless the whole net return, compared with the value of tangibles, is above a satisfactory return on tangible investment alone, the addition of stock issued for franchise will be regarded as "water," and detract from the value of the entire issue, and I think this conclusive proof that value on a franchise depends wholly on what actual investment can earn."

In this particular instance stock to the amount of $7 781 000 had been issued in 1884 and divided among stockholders without any consideration, which stock represented the company's own valuation of its franchise at that date. The Court, in fixing a value, held that it would be proper to increase it proportionately to the increase in tangible property; this he did, fixing the franchise value at more than $12 000 000. The Supreme Court of the United States, in disposing of this, says (212 U. S., 47):

"But although the state ought for these reasons [applicable to this case—not general], to be bound to recognize the value agreed upon in 1884 as part of the property upon which a reasonable return can be demanded, we do not think an increase in that valuation ought to be allowed upon the theory suggested by the Court below. Because the amount of gas supplied has increased to the extent stated, and the other and tangible property of the corporations has increased so largely in value, is not, as it seems to us, any reason for attributing a like proportional increase in the value of the franchises. Real estate may have increased in value very largely, as also the personal property, without any necessary increase in the value of the franchises. Its past value was founded upon the opportunity of obtaining these enormous and excessive returns upon the property of the company, without legislative interference with the price for the supply of gas, but that immunity for the future was, of course, uncertain, and the moment it ceased and the legislature reduced the earnings to a reasonable sum, the great value of the franchises would be at once and unfavorably affected, but how much so it is not possible for us to see. The value would most certainly not increase."

The Court did not concur in the increase of the franchise value, and, in dismissing this subject, says:

"What has been said herein regarding the value of the franchises in this case has been necessarily founded upon its own peculiar facts, and the decision can form no precedent in regard to the valuation of franchises generally where the facts are not similar to those in the case before us."

It appears, then, from this, the latest case, that:

1.—The view of the lower Court that a franchise or intangible value is not separable, and that if there be a value it must be determined from the earnings, is concurred in by the Supreme Court.

2.—That the arbitrary increase of franchise value, by the lower Court, proportional to the normal increase of the physical property, is not concurred in.

3.—Inferentially, it appears that the acquiescence of the State in the franchise value of 1884 is the main reason for permitting that value to stand, and it would seem to follow, from the reasoning of the Court, that it is very questionable whether any franchise or intangible value based on excessive rates should be allowed to stand.

Another view of franchise values, as stated by George H. Benzenberg, Past-President, Am. Soc. C. E., in discussing water-works franchises, is as follows:

"Some contend that a franchise is simply and purely a privilege given by the municipality to a water company to utilize the streets for the purpose of laying a system of pipes through which it may distribute and deliver water. It is not a license to do business, but a privilege to use public streets, alleys, and grounds. * * * If that interpretation is the proper one, the value of the franchise, if the property is to be purchased by a municipality, is comparatively nothing. If the property is to be purchased by another company, it represents all of the great value that such franchise possesses to the original holder, together with all the privilege it confers; but in the event it is purchased by the city, it is dispossessed of that certain element of value, and I think for that reason it is stipulated in many of the ordinances that no value shall be placed on the franchise by appraisers."

In the paragraph just quoted, it is evident that the term "franchise" is used in a restricted sense, and refers to the ordinance or contract from a municipal corporation granting the right to operate on specific terms, rather than the broad use of the word as indicating all rights derived from general laws or special contracts or grants. The point, however, is applicable to the case of any corporation occupying public ground.

It is believed that enough argument has been adduced to show that any attempt to give separate value to the different elements that enter into the intangible value of a property is a very risky proceeding on the part of appraisers, and to support further the contention that, as a business proposition, the value of any property depends on its earnings; that the franchise simply protects the owners of the property in their enjoyment of those earnings; that the value of the franchise merges in the "fair value" of the property, and that the franchise can have no special value of itself unless the earnings of the property are in excess of a usual and fair rate on the actual investment. In case there are surplus earnings, they measure and determine not only the value of the franchise, but also the value of all other non-physical elements. If this be true, any readjustment of rates, any restriction of operations, or other form of legislative control which would unfavorably and violently affect earnings, is bound to hold down franchise or non-physical values; as it would not seem possible to read into the various decisions any intention on the part of the Court to base the right to demand fair return on anything but the "fair value of the property being used."

The writer, therefore, reaches the following conclusions regarding non-physical values:

1.—That all the different non-physical elements of value are inseparable.

2.—That in the case of very many properties, no non-physical value can attach, and in many cases this value will be a negative or subtractive quantity.

3.—That in the case of properties located so as to secure either a monopoly of business in a congested territory, or in which the construction, location, strategic position, or economic excellence of design, is such that, on a schedule of rates which is fair and reasonable for competitors less advantageously situated, an earning is secured which is in excess of usual returns, a non-physical value of considerable magnitude may very properly be assigned.

4.—That, for the computation of non-physical values, the income account of the property under consideration affords the only legitimate basis, but even then consideration must be given to duration of franchise, reasonableness of rates, and other modifying conditions, and also, possibly, the purpose for which the appraisal is made may determine whether or not a non-physical value may be used. The language of the Court in the Knoxville and Omaha cases apparently leaves this a very open question.

This brings us substantially to the conclusion reached by Professor Adams in 1900, and a careful study of the method laid down by him shows nothing that cannot be accepted as fair and reasonable. His plan should be extended so as to cover subtractive values or the case of properties showing a deficit.

This method has the merit of being based on the actual earnings and expenses of the company under investigation and on the value of the physical property as already computed. It does not introduce a mass of purely supposititious figures, nor depend on hypothesis. The proposition is simply this: If a property earns only its operating expenses, including therein proper depreciation reserves, taxes, and such a percentage on its actual invested capital as could be earned by that capital if invested in good non-taxable bonds or other like security, it is worth no more than its physical property is worth. If it earns more than that, it is due to the franchise, going concern, or other intangible elements of value, and to determine that value, capitalize the surplus.

It takes several years for a property to reach its normal earning capacity after construction is completed, and in the investigation of a property of comparatively recent construction, where the gross and net earnings show a steady annual increase, the application of a negative or subtractive value should be made with great caution; but where the earnings have been fairly uniform and stationary for a period of years, and the property does not earn a sufficient sum to care for depreciation and annuity, it is clear that the value as an earning investment is less than the determined physical value, and that the physical valuation should be reduced by some amount to arrive at the "fair value."

The Courts hold that public service corporations are entitled to earn:

(*a*) Operating expenses,
(*b*) Expenses of maintenance and running repair,
(*c*) Taxes,
(*d*) A sinking fund from earnings to cover depreciation and obsolescence, and
(*e*) A reasonable profit on the fair value of the property.

An investigation of non-physical values should then include an analysis of operating expenses, to determine that additions and betterments to property are not included therein.

The general practice of corporations in the past has been to ignore any reserve to cover depreciation and obsolescence. If, at the beginning of operations of any property, such a sum should be annually set aside out of earnings as should, when invested as a sinking fund, maintain the integrity of the investment, then this amortization fund at any period, plus the depreciated value of the physical property, should equal the amount of the total capital actually invested in the property. In most cases this has not been done, and the Supreme Court in the Knoxville Water Case holds that, by reason of the failure to create such a fund, whether due to carelessness, excessive dividends, or other cause, the company must lose the amount of capital represented by the depreciation that has taken place. In making a computation of intangible values, it is certainly proper to consider the income account as averaged over a period of years to avoid violent fluctuations of gross or net earnings, and a depreciation reserve should be determined for such years, as it cannot be claimed that, unless such an amortization fund is earned, in addition to other operating expenses and taxes, there is any non-physical value.

Professor Adams covered the depreciation in the Michigan work in the 4% annuity which was deducted before non-physical values were computed. The writer is inclined to go a step farther than Professor Adams, and hold that, before any intangible values can be attached to the property, it should earn not only all operating expenses, taxes, and reserve for depreciation; but also interest on the actual investment equivalent to the return that would be had were the money invested in a non-taxable bond, say 4%, and that any earnings in excess of such a sum might be termed properly "earnings on franchise," or intangible values.

On this basis, then, a rule would be formulated, being that of Professor Adams, with some modifications:

1.—Deduct from gross earnings from operation the aggregate of operating expenses, including in operating expenses an anual sinking fund to amortize the depreciation and obsolescence, and the remainder may be termed "income from operation."

2.—To this income from operation add income from investment, giving "total income," which represents the amount at the disposal of the corporation for the support of its capital and for the determination of its annual surplus.

3.—From "total income," deduct taxes, rents paid for lease of operated property (provided such property is not included in the appraisal), and improvements chargeable to income. The remainder represents the income after all charges against operation of property, and maintenance of the integrity of the capital investment have been cared for.

4.—From this remainder (*3*) deduct such a percentage of the value of the physical property (representing invested capital) as would equal the income of that capital if invested in government or other non-taxable bonds. The remainder would represent surplus, which, capitalized at a proper rate, would equal the value of intangible or non-physical properties, which is to be added to the appraised value of the "physical property."

5.—If, instead of a surplus, a deficit occurs, a careful study of all the conditions surrounding the operations of the property should be made, and, if there be no reasonable expectation of increase of earnings, or other modifying conditions, a proper figure, based on the average deficit, should be determined, and, as a negative intangible value, deducted from the value of the physical property.

6.—In the determination of rates, to be used in computing income and for capitalizing surplus or deficit, the greatest of care must be exercised to adopt such figures as will be proper and absolutely just.

CONCLUSION.

The subject of valuation is so appallingly great that, notwithstanding the length this paper has reached, many points have not been covered.

No discussion of the method of valuation by capitalization of net earnings, which is practically that adopted by Professor Adams in his commercial valuation, has been attempted; nor has any attempt been made to describe the stock and bond method. Neither method is adaptable to the requirements of any public appraisal.

The so-called cash investment in property, or the actual cost of construction through the entire history of the property, cannot be sustained by any process of argument as a proper method of valuation, nor can the method of computing the cost of construction of an adequate modern property assumed to replace the existing property. The scope of a valuation must be limited to the property as it exists on the date of the appraisal, and it would be equally fallacious to include non-existent and long-perished facilities, or to assume a hypothetical and never-existing property.

There are many intricate problems in connection with a valuation for rate-making or taxation which really belong to these undertakings, not to valuation. They are usually brought into the discussion of valuation, but have been here excluded. Among these are the separation of interstate from intra-state business, and others, of great interest, it is true, but foreign to the subject of valuation.

The question of the fair return on money invested is not referred to, for the reason that it has no direct bearing on valuation, and for the further reason that it has been quite exhaustively discussed in the papers listed in the Appendix. The writer desires to make clear the fact that he is not advocating low rates *per se*. The rate must be determined to meet the special requirements of each investigation. The Supreme Court of Maine says (97 Maine):

> "The reasonableness of the rate may for a time be affected by the degree of hazard to which the original enterprise was naturally subjected. That is such hazard only as may have been justly contemplated by those who made the original investment, and not unforeseen and emergent risks, and such allowances may be made as is demanded by ample and fair public policy."

While the Supreme Court of the United States, in Willcox *vs.* Consolidated Gas (212 U. S., 12), fixed a rate of 5½% as reasonable in that instance, they said:

> "No particular rate of compensation must in all cases be regarded as sufficient for capital invested in business enterprises. Such compensation must depend greatly on circumstances and locality. Among

other things the amount of risk in the business is an important factor, as well as the locality where the business is conducted and the rate expected and usually realized there upon investments of a somewhat similar nature with regard to the risk attending them. There may be other matters which in some cases might also be properly taken into account in determining the rate which an investor might properly expect or hope to receive and which he would be entitled to without legislative interference. The less risk, the less right to any unusual return upon the investments."

In view of these dicta, it is needless to argue whether a rate of 6% or 10%, or 15%, or more, be reasonable.

The writer has herein endeavored to narrate the story of the Michigan appraisal in some detail, to review briefly subsequent similar work, to present the main points in the legal decisions bearing on appraisal practice, and to present his own views as to proper and legitimate methods of valuation in the light of judicial opinions. He has attempted to do this in the spirit of absolute fairness, without permitting either early years of training in corporation service, or more recent investigations for State and city, to bias the presentation of truths.

The subject is one which has not attracted the average citizen sufficiently to compel him to give it deep study. Those who are familiar with it all too frequently have views biased by interest, and it is hardly conceivable that any final conclusion will be reached until each and all of the main issues are determined by the Courts. When thus determined, it will be done with wisdom and with justice. It is impossible to study the cases referred to without being impressed with the absolute fairness of this great tribunal. Quotations from decisions have been included at considerable length in order to obviate the criticism that the references do not convey the exact meaning of the Courts.

The writer acknowledges the valuable suggestions, criticisms, and information furnished him by Professors Henry C. Adams, Mortimer E. Cooley and W. D. Pence; Mr. Henry L. Gray, Engineer of the Railroad Commission, Washington; Mr. D. F. Jurgensen, Engineer, Railroad and Warehouse Commission, Minnesota; Mr. Bion J. Arnold, and others who have made possible the presentation of data regarding State and other appraisals.

Bibliography.—Accompanying this paper will be found a bibliography of the principal articles on the subject of property valuation.

APPENDIX

BIBLIOGRAPHY.

Railroad Valuation.—

"The Appraisal of Plants for Public Services." Nicholas S. Hill, Jr. *The Engineering Record,* June 8th, 1901. A review of the principles on which a property is valued when purchased by private parties or by municipalities.

"The Value of Railways and Their Capitalization." H. T. Newcomb. *Railroad Gazette,* August 29th, 1902. Abstract from *Yale Review,* August, 1902.

"The Census Office Railroad Valuation." (Editorial.) *Railroad Gazette,* September 1st, 1905. A discussion of the work of Professor Henry C. Adams, Statistician of the Interstate Commerce Commission, and his assistants.

"Railroad Taxes and Plans for Ascertaining the Fair Valuation of Railroad Property." *The Railway Age,* September 8th, 1905. Report presented at the meeting of the National Association of Railroad Commissioners, at Deadwood, S. Dak.

"Railroad Valuations in State Reports." Professor Harold M. Bowman. *Railroad Gazette,* September 8th, 1905. Abstract of a report, which explains briefly the systems of valuation provided for by the laws of the several States, with a critical review of the systems and administrative reports.

"The Determination of Physical Values." Clinton S. Burns, M. Am. Soc. C. E. *The Engineering Record,* September 16th, 1905. Presents a mathematical formula for fixing depreciation on articles, based on age, with quite a complete demonstration of the theory presented.

"Valuation of Railroad Property." Henry Fink. (Serial.) *Railway Age Gazette,* July 24th, 1908, *et seq.* A brief review of several methods.

"The Valuation of Railways." (Serial.) *Railway Age Gazette,* January 22d, 1909, *et seq.* A thorough discussion of the subject, and one of the best presentations of it from a rational corporation standpoint.

"Some Neglected Factors of Fair Valuation." (Editorial.) *Railway Age Gazette,* March 5th, 1909.

"Railway Capital and Values." W. H. Williams. (Serial.) *Railway Age Gazette,* April 2d, 1909, *et seq.* An address setting forth at length the views of the railway managers who oppose valuation of property for any purpose.

"Valuation of Street Railway Properties." *Electric Railway Journal,* June 19th, 1909. A general discussion of the subject.

"Commercial Valuation of Railway Operating Property in the United States: 1904." Bulletin 21, United States Bureau of the Census. Contains an exhaustive discussion of sundry methods of valuation. The most complete series of papers on valuation yet published.

The Chicago Appraisal.—

Report to the Common Council on Railroad Valuation. B. J. Arnold, M. Am. Soc. C. E., M. E. Cooley, and A. B. Du Pont.

The Michigan Appraisal.—

"Expert Valuation of Railway and Other Corporate Property in Michigan." E. E. R. Tratman, Assoc. M. Am. Soc. C. E. *Engineering News,* December 20th, 1900. A descriptive paper.

"What is the Value of a Railroad for the Purpose of Taxation?" Charles Hansel, M. Am. Soc. C. E. *Railroad Gazette,* April 19th, 1901. Discussion of the work done by Professor M. E. Cooley, and on valuation in general.

"Michigan Railroad Appraisal—Valuation of Physical Properties." Professor Mortimer E. Cooley. Bulletin 21, U. S. Bureau of the Census, p. 76.

"Michigan Railroad Appraisal—Valuation of Non-Physical Elements of Railway Property." Professor Henry C. Adams. Bulletin 21, U. S. Bureau of the Census, p. 78.

The Minnesota Appraisal.—

"Valuation of Railway Property." A. S. Cutler. *Year Book,* University of Minnesota, 1908. An account of the methods used for obtaining and checking the information.

Report on the Valuation of Railways in Minnesota, January, 1909. Minnesota State Railroad Commission.

"Valuation of Railways in Minnesota." *Railway Age Gazette,* February 5th, 1909. A descriptive article.

The Texas Appraisal.—

"Railroad Franchise Values in Texas." W. H. Coverdale, Assoc.

M. Am. Soc. C. E. *Railroad Gazette*, February 12th, 1904. Discussion of methods used in Texas.

"Methods Used by the Railroad Commission of Texas Under the Stock and Bond Law, in Valuing Railroad Properties." R. A. Thompson, Assoc. M. Am. Soc. C. E., with discussion by Messrs. E. L. Corthell, F. Lavis, W. H. Coverdale, and W. D. Taylor. *Transactions*, Am. Soc. C. E., Vol. LII, p. 328, *et seq.*

The Washington Appraisal.—

"Report to the Washington Railroad Commission on the Valuation of Railways in Washington." Halbert P. Gillette, M. Am. Soc. C. E. *Engineering-Contracting*, April 7th, 1909.

The Wisconsin Appraisal.—

"Wisconsin Railroad Valuation." W. D. Taylor, M. Am. Soc. C. E. Bulletin 21, U. S. Bureau of the Census, p. 82.

"The Appraisement of the Physical Value of Wisconsin Railways for the Purpose of Taxation." W. D. Taylor, M. Am. Soc. C. E. *Engineering News*, March 31st, 1904.

Discussion on "Valuation of Railroad Properties." W. D. Taylor, M. Am. Soc. C. E. *Transactions*, Am. Soc. C. E., Vol. LII, p. 353.

"Report to the Tax Commission." W. D. Taylor, M. Am. Soc. C. E. Report of the Wisconsin Tax Commission, 1907, p. 269.

"The Work of the Joint Engineering Staff of the Wisconsin Tax and Railroad Commissions." W. D. Pence, M. Am. Soc. C. E. *Journal*, Western Society of Engineers, Vol. XIV, p. 73. (Abstract.) *Engineering News*, March 4th, 1909.

Water-Works Valuation.—

"Water-Works Valuation and Fair Rates, in the Light of the Maine Supreme Court Decisions, in the Waterville and Brunswick Cases." Leonard Metcalf, M. Am. Soc. C. E. *Transactions*, Am. Soc. C. E., Vol. LXIV, p. 1. (A complete bibliography of the subject of water-works valuation may be found on p. 69 of Mr. Metcalf's paper.)

Vol. XXXVI. NOVEMBER, 1910. No. 9.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE ARCH PRINCIPLE IN ENGINEERING AND ESTHETIC ASPECTS, AND ITS APPLICATION TO LONG SPANS.

Discussion.*

BY MESSRS. MAX M. MILLER, LEON S. MOISSEIFF, FR. ENGESSER, AND R. KROHN.

Mr. Miller.

MAX M. MILLER, ASSOC. M. AM. SOC. C. E. (by letter).—Esthetics in design is an essential branch of successful bridge engineering which, in the past, has been sadly neglected in the training and career of constructing and designing engineers. Until the last few years concerted action on the part of bridge owners, designers, and manufacturers to produce a pleasing structure was almost unknown. In the early days of bridge building the practice of awarding the contract for the construction of a bridge to the lowest bidder, whose design was prepared in competition with those of other bridge companies, was one of the most prolific sources of ugly structures; but, by degrees, a change for the better has been taking place.

In an increasing number of cases, the information furnished to bidders nowadays is sufficiently exact to eliminate some of the earlier sources of trouble. In practically all important structures and in more and more common structures, the type of design, including its esthetic treatment, is at least partly settled when the bidder is asked to compete. Thus the designing engineer and those associated with him assume an increasing responsibility as to the general appearance of a bridge.

In designing long-span bridges, the engineer is confronted with the problem of adapting a single and comparatively new material to

---

*This discussion (of the paper by C. R. Grimm, M. Am. Soc. C. E., printed in *Proceedings* for September, 1910, and presented at the meeting of November 2d, 1910), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

Mr. Miller. an uncommon use. This in itself would present unusual difficulties in the way of satisfactory esthetic treatment; for it must be borne in mind that our conceptions of a pleasing structure are derived from past or existing works. In this respect, it is, in some degree, unfortunate that the most suitable material for the construction of bridges of great magnitude should not be better adapted to esthetic treatment; yet the superiority accorded to stone and masonry may be due less to intrinsic merit than to a longer familarity with their uses in construction.

Since bridges, including many ordinary crossings, are being built to an increasing extent as monumental structures, their esthetic design is becoming of correspondingly increasing importance. A pleasing effect in any structure can be attained in one of two ways, or, perhaps, by the proper combination of both:

First, by keeping constantly in mind the purpose for which the structure is being designed, and by proportioning its principal features so that the utilitarian and economical elements are blended, yet simultaneously discerned and appreciated by the observer. In such structures, architectural effect should be attained without recourse to embellishments or ornamentation of any kind, the effect arising solely from line and mass. Most masonry bridges, and also steel bridges of very long span, are included in this class. As such structures form important features of the surrounding landscape, it is of the utmost importance that painstaking and exhaustive studies be given to them.

A second method of producing a satisfactory architectural effect, in a structure which otherwise would have a distasteful appearance, is by the addition of a certain amount of proper screening, but always in such a manner as not to hide the leading features of the design. The Alexander III Bridge, at Paris, is one of the most successful illustrations of this method of treatment.

The question as to where engineering ends and architecture begins in the case of a bridge is not an easy one to settle, and, consequently, it is undesirable to establish hard, fixed rules for the control of esthetic principles; nevertheless, we may lay down a few fundamental principles which are always found in a satisfactory esthetic structure, unless violated for good and obvious reasons. The author has mentioned some of the requirements, such as symmetry, odd number of spans decreasing in length from the center toward the ends, relative position of crown of arches and roadway, etc. He then says:

> "Desirable as these conditions appear, they are nevertheless accidental, and cannot be put forward as the cause of the satisfaction felt in viewing an esthetic structure; the finding of the true cause of this satisfaction, however, is the vital point for discussion, carrying with it a hint to shape a design so that it will be esthetically effective."

Then he goes on seeking that cause, and concludes by saying: Mr. Miller.

"It is this fight for supremacy, between opposing forces, the display of the tensest energy, the strength of the arch in action, the parry of a thrust and its safe guidance to earth, which ever appeal to the imagination and reveal the beauty."

This conclusion hardly accords with the majority of opinions heretofore expressed. To the writer these very conditions of symmetry, odd number of spans (up to the point where it becomes necessary to count them to determine whether they are odd or even), and position of roadway, are elements entering into a good-looking bridge. There are two other elements, however, which the writer would put at the head of the list: One of these the author casually mentions; the other he neglects entirely.

The first is fitness, not only in regard to strength and economy, but also surroundings. The author says: "fitness cannot be regarded as causing the esthetic effect of a bridge." It seems to the writer that the subject deserves more attention than Mr. Grimm has given it. Of course it is well known that there are very few structures which cannot be made strong enough, and, therefore, fit for use; they may even satisfy the requirements of economy and yet be inappropriate, for strength and economy may be combined in a structure and yet it may be out of place on account of the surroundings. In such a case, fitness has everything to do with the question of the proper design to be adopted for a given crossing. In other words, the special purpose for which a structure is erected should be regarded as of such paramount importance in its design as to create in the mind a satisfactory impression of the suitability of that particular design for meeting the exigencies of the case.

As an illustration, consider the Niagara Gorge. On account of the enormous natural abutments available, the writer has yet to see a more satisfactory bridge design for this location than some form of the arch. Again, referring to the East River, on account of the comparatively level banks, and, consequently, the absence of suitable means for resisting the enormous thrust which an arch design would require, both fitness and economy seem to point to the suspension bridge as being the most appropriate design yet suggested.

The second element is simplicity, one of the most eminent qualities in a truly esthetic structure; for in every case the most beautiful and satisfactory results are obtained by the simplest arrangement of parts. A maze of members, some true, some false, and, occasionally, others redundant, such as may be seen in a long cantilever truss, creates anything but a favorable impression on the mind, because one is unable to distinguish at a glance the particular function of each member in the structure. In the suspension bridge or the arch, however, there are but five members: the roadway, the spandrel or suspenders, the arch ring

Mr. Miller. or cable, the piers or towers, and the abutments or anchorages. It needs no special education or training to distinguish the peculiar function of each of these elements; even the most ignorant cannot but understand the necessity for each.

While these elements of fitness, simplicity, symmetry, number of spans, position of roadway, etc., are by no means all that may enter into a properly designed bridge, yet it is claimed that they have more to do with making a structure pleasing than merely the fight for supremacy between opposing forces. Furthermore, in his defence of the arch, the author mentions conditions which (the writer infers he would have us believe) place the esthetic value of the arch above that of other designs. For example, he says:

> "A force like that of gravity acting along a vertical line is a common phenomenon, it is constantly before our eyes, so that it has ceased to interest us, certainly not in any marked degree, while, on the contrary, the appearance of inclined or horizontal forces strikes the mind as something new, and awakens interest."

As far as this statement is concerned, what about cantilever bridges with horizontal or inclined lower chords carrying an enormous thrust? These fulfill the conditions as specified and illustrate further the principle of supremacy of forces, as enunciated by the author; but, as a rule, a cantilever bridge is far from being as pleasing a structure as an arch or suspension bridge.

Before leaving the subject of arches, it may be well to point out one assumption made by the author in his designs on Plate CLXII, which rarely obtains in a span opening of the size of the one discussed, and which is an essential if not the controlling feature of economy in the adoption of his design of arches. Reference is made to the character of the approaches. In order that such a design should be suitable, gigantic natural abutments are necessary. These the author has supplied in his design, but he says nothing about them in his paper. As a rule, such bridges are required only in the lowlands of the country, across streams with wide-spreading, sloping, alluvial banks, furnishing no natural support for the well-nigh inconceivable thrust which such a design requires. It might not be difficult to select a suitable location for such a bridge; but the question would arise whether the traffic accommodated would warrant the expenditure required. Doubtless much that the author has left unsaid hinges on the question of approaches.

When properly designed, a suspension bridge can hardly be surpassed by any other type in point of esthetics; still, the author seems to feel that necessity for a small horizontal movement of the cables at the tops of the towers contradicts the function of a column so as to affect its esthetics. While this movement should by no means be neglected by the engineer, yet, as far as it affects the appearance of a

Mr. Miller.

bridge, it amounts to nothing. Under conditions of maximum angular variation, the deflection of the columns of a properly designed tower for a bridge not exceeding the maximum span yet constructed, is practically unnoticeable. The rocker-bent, suggested by the author as a substitute, is open to the more serious objection that its proper esthetic treatment would require a tower with a narrowing base, which is entirely at variance with esthetic design.

On the whole, then, although the steel arch may have before it a great theoretical field of usefulness as applied to long spans, the writer can hardly believe that it will find many applications to actual crossings, on account of the reason just cited; neither can he agree with the author's opinion "that a skilfully designed arch bridge is superior in every respect to any cantilever or suspension bridge."

Each type has its own field of usefulness, and although the field of one may overlap that of another for certain locations, we may hardly expect to see any one design fully supplanted by another.

Mr. Moisseiff.

LEON S. MOISSEIFF, M. AM. SOC. C. E.—The author discusses the arch principle in the abstract and frequently succeeds in illuminating the subject from an uncommon point of view, which awakens many dormant suggestions in the reader and leads to further speculation and ideas. The paper deserves a full and extended discussion by engineers interested in long-span bridges. Such a discussion would bring out many novel points of view, and should prove of mutual benefit.

Mr. Grimm's predilection for the arch principle and, among arches, for the upright arch, appears rather early in his paper. Evidently it is based on the "estimates of weights for bridges of widely different designs, three arch bridges, a cantilever, and a suspension bridge," which estimates, the author states later, he has made. However, it appears that other types of bridges are dismissed in too summary a manner in favor of the upright arch. The inverted arch or suspension bridge certainly deserves more consideration and a deeper study of its merits.

It may be well to remember that a survey of actual achievements discloses the significant fact that the length of span of the longest arch has been doubled successfully by its rivals, the cantilever and suspension bridges. The arch type, therefore, has to overcome the strides made by these rivals, and to prove that it is more economical in construction, stiffer in use, and handsomer in appearance. This the author virtually undertakes to prove for the upright arch. In his opinion, the crescent arch is the most economical, most rigid, and the best looking type of bridge for long spans such as, for instance, a span of 1 800 ft. Throughout the paper he argues his case on three points, namely, economy, stiffness, and looks; but he fails to be convincing.

Mr. isseiff. No data are given by the author, which would enable the reader to compare, in some way, his designs of cantilever and suspension bridges and those of the arches denoted as Types *A, B,* and *C.* Bridges of the dimensions compared are not built too frequently, and their design is not yet standardized. Such structures require much study, and it may easily be possible that individual differences in their design may suffice to overcome the differences in tonnage computed by the author.

In the table of estimated weights the author gives that of the suspension bridge as 60 000 tons, that of the arch bridge *A* as 53 000 tons, and that of the arch bridge *B* as 45 000 tons. According to this estimate the suspension bridge weighs 7 000 tons more than arch bridge *A,* and arch bridge *A* weighs 8 000 tons more than arch bridge *B.*

The only difference between Bridges *A* and *B* is that the side trusses in Type *A* are curved with a versine of 40 ft., while those in Type *B* are horizontal. This difference in outline, which, at first glance, appears to be of no great importance, is, however, sufficient, according to the author's statement, to cause a difference of 8 000 tons, or 15%, in the weight of arch bridge *A.* How much variation in design would then be required to overcome the difference of less than 12% between the estimated weights of the suspension bridge and arch bridge *A?*

This is mentioned merely to illustrate the writer's statement that the author has not furnished sufficient data for a comparison of the different types discussed. The objection may be made that the author has endeavored to design the different types according to uniform rules and specifications, and that the comparison is fair; but it will be admitted that the design of a suspension bridge will differ very materially from that of an arch bridge in many important points, beginning with the choice of the versed sine to the length of the panels and ending with the proper allowable stresses in the component parts of the suspension bridge. Engineers will first have to be satisfied that the best or equally good designs of the different types have been shown for comparison, before they will be ready to accept any estimated weights, even if made by an able engineer.

This again can be illustrated by one of the author's assumptions. All the bridges compared are supposed to be of nickel steel throughout. It is hardly good engineering at the present time to make the floor system of a bridge of nickel steel except in case of extreme necessity. A bridge floor needs stiffness, and this can be supplied as well and at a less cost by structural steel. Nickel steel is not stiffer than structural steel, the coefficients of elasticity being practically the same; nor are floor beams and stringers designed to exact theoretical sections at any point. Constant sections and least thicknesses of plates and angles require much

Mr. Moisseiff.

overrun. The greater strength of nickel steel, therefore, could not be utilized to advantage in a floor system. True, the floor systems of all the bridges have been assumed to be of the same material, and, at first thought, the comparison is fair to all types; but second thought will disclose the fact that a suspension bridge, especially one with wire cables, will carry a uniformly distributed fixed load, such as the floor system, more economically than any other type considered. The writer believes that a floor system of structural steel, which, of course, would be heavier, would show the suspension bridge to be more advantageous.

"A suspension bridge would solve the problem, provided great care was taken in its design as a railroad bridge, but the writer does not consider it the best solution. Skilfully designed, the bridge proper shows economy and has a pleasing appearance, but it also has disadvantages. The tonnage is influenced considerably by the anchor chains and anchorages, and particularly by the towers and the general stiffness. Further, it is to be noted that the effects due to temperature changes and yielding of the anchorage masonry, and also the deflections, are considerably greater in suspension bridges than in arches. It is very difficult to inspect the anchorages, which is a serious drawback, as the safety of the bridge is dependent on them, and the anchorage masonry is a very costly item."

The writer does not agree with the above statement of the author. Skilful design and great care are required for any type of long-span bridge, and in discussions of various types it is always tacitly assumed that the design is at the height of the art, and that the best of care is given it, be it arch, cantilever, or suspension bridge. The effects due to temperature changes and yielding of anchorage masonry are not considerably greater in suspension bridges than in arches. There is no reason why they should differ for an arch of Type *A* or *B* and a suspension bridge of identical spans and versed sine. For a suspension bridge the elongation of the main span, due to an increase in temperature, the curve being of the same length, will be the same; that due to the side spans will be greater, as the length of the back stay curve is greater than that of the horizontal chord of the side span in the arch type *B*. For the dimensions used by Mr. Grimm the writer has computed the difference to be about 6% of the side-span effect, or 2.5% of the total effect, of temperature changes. Against this the counteracting effect of the tower elongation for the same change in temperature is to be added, which will make the total effect due to temperature changes the same for both types. This also holds true for the effect of yielding of the anchorage masonry.

The greater deflection of the suspension bridge is due only to the higher stress used for the cable wire; if, for instance, a nickel-steel chain of eye-bars is used, having the same unit stresses as the arch rib, practically the same deflection will result. This, of course, presupposes equivalent depth of stiffening trusses.

Mr. Ioisseiff. It is not difficult to inspect the anchorages of a suspension bridge if proper provision be made for it. If, as in present practice, the anchor chains are embedded in concrete, they cannot be inspected. This is done because the experience of a century has demonstrated it to be the best way of preserving them. There is, however, no difficulty in leaving the anchor chains open for inspection. It is true that anchorage masonry is costly, but so is abutment masonry for an extremely heavy arch thrust transmitted in a horizontal direction, which has to be resisted by the stability of a masonry abutment.

It is not true, as stated in the paper, that a suspension bridge is far more sensitive to a yielding of its supports than any arch bridge. With towers hinged at the foot and a shallow stiffening truss it will be, on the contrary, less sensitive. For equivalent proportions the same sensitiveness will result.

The author proceeds to demonstrate the inherent safety of the arch bridge by a paradoxical example. Suppose, he says, the side spans or the abutment masonry offer no resistance to the thrust of the arch, "even then the central ribs under their own weights would survive the injury, but by stressing the steel nearly to the elastic limit." The author finds the realization of this supposition improbable, but possible, "for example, by an earthquake." A suspension bridge would be destroyed "long before the pull in the anchor chains reached the zero value." This is true, but why is the failure of the river piers of the arch not just as possible "for example, by an earthquake"?

In reply to the above paradox may be brought the more rational argument that the stiffening truss of a suspension bridge may be crippled without endangering the bridge, while if a chord of the arch truss should fail, the arch in all probability would collapse.

The tentative proposal of an arch truss in connection with a wire cable as a permanent carrying member sounds well in the abstract. The question is however in order, why build a suspension bridge to carry the fixed load, or most of it, and an arch to carry the remaining load? Would it not be better to add sufficient steel to build a suspension bridge of the required stiffness, and omit the arch altogether, and be cheaper in the end? Where would the supposed economy of the arch assert itself in the combination of a cable and an arch?

As to the practical application of counterweights to the enormous weights represented by the pull exerted by the cable ends of suspension bridges of long spans, the difficulties are great and necessarily expensive.

Not knowing the forces computed by the author, the writer ventures to guess that the pull of the cables carrying their own weight and only one-half of the total fixed load on the arch, will be not less than 10 000 tons. To take care of this weight in the form of a counterweight will prove costly in materials and work.

Mr. Moisseiff.

As reference is made in the paper to the use of counterweights in the Loschwitz Bridge, in Germany, the writer wishes to quote from Professor Mehrten's great work on the evolution of iron and steel bridges, published in 1908:

> "The Loschwitz Highway Bridge has been opened in 1893 and is neither a cable nor a chain bridge. Its chords are riveted throughout and it has three hinges. The pull of the arch is taken up artificially by a bent lever system which is hidden in each end pier. In this and in other matters the bridge is an exceptional structure. Its peculiarities will, however, hardly cause imitation. After the experience of a century there is no need for an artificial provision for the arch thrust. This method belongs to the arrangements which have been denoted as not worthy of imitation."

The author's discussion of the esthetics of bridges is generally instructive and contains many good points, but his application of these principles to the arch bridge with extra deep crescent ribs, as illustrated in types *A, B,* and *C,* is not very successful.

The high esthetic valuation of the arch type has been transmitted to us by "esthetic habit" from the observation of masonry arches. These arches and their proportions have satisfied our senses, and we have formed the habit of being pleased by their appearance. These proportions show, however, no such depth of arch at the crown as the one proposed by the author. A comparison of a considerable number of masonry arches will disclose the fact that the ratio of depth at the crown to versine of the intrados is far less than 110:250, as is the case in the author's design. In other words, there is far too much depth of arch in the deep crescent arch than is compatible with a good esthetic impression.

The long panels which necessarily follow the great depth of the arch, result in lines too far apart and give an empty appearance. The observer will miss the simple, solid line of the arch rib to which his esthetic sense is accustomed; he will also miss the rhythm of recurring symmetric lines.

The growing depth of the arch toward the middle does not agree with the increase of the resultant thrust toward the abutments, and does not give that sense of safety and satisfaction which the author ascribes to it. As to the esthetic appearance of the crescent arch, opinions are divided. Some well-known authorities have compared it to the appearance of a man balancing on his toes. The combination of cables and a suspended arch will not improve the appearance of the structure.

In conclusion, the writer wishes to state that credit is due to those engineers who have introduced nickel steel in bridge building, and have expanded the field of long-span bridges. The use of high resistance steel will enable the bridge builder to overcome heretofore

Mr. Moisseiff. impossible difficulties, and will lead to many interesting discussions, Mr. Grimm's able paper being one of the first in this line.

Mr. Engesser. FR. ENGESSER,* ESQ. (by letter).—The writer agrees fully with Mr. Grimm in all essential points, and particularly in his high estimation of the value of arched ribs, which require less steel than cantilevers and continuous trusses for long spans, as the abutments relieve the steel of a part of its work. Further, as these ribs are subjected only to small secondary stresses, they take first place in esthetic respects, especially if the floor passes over the crown, as is the case with masonry bridges. On the other hand, they necessitate more massive abutments than bridges with simple trusses, and can only be applied advantageously if the soil is good. Compared with cantilever bridges, arch bridges are at a disadvantage in point of erection, but this can be removed by the application of a cable, as proposed by Mr. Grimm; however, in such a case, the rib would lose some of its characteristic beauty.

Suspension bridges require a great tonnage of steel for anchorages and towers, and on that account the most favorable dip of the cables cannot be obtained as a rule, and for spans of 1 800 ft. financial conditions are not as favorable as for arch bridges. On the other hand, the cables admit of higher stresses, on account of excellent material, are less influenced by wind, and, as they need no extra material for buckling, a longer span than for an arch is theoretically possible. By a proper mode of construction, it is possible to avoid too great a flexibility, which circumstance is of lesser importance with increasing length of span and dead load. While a suspension bridge with stiffening trusses of the usual depth would collapse under the hardly possible assumption of a complete yielding of its anchorage masonry, the sickle-shaped arch would resist destruction on account of its great depth, but the stiffening truss would stand if it were given the same depth as that of the sickle. The secondary stresses of suspension bridges with the common shallow stiffening trusses are smaller than those of deep sickle trusses, if one considers only such horizontal displacements of the masonry as occur under ordinary circumstances.

The appearance of properly designed suspension bridges is quite satisfactory; the play of forces is easily comprehensible, and, in the writer's opinion, the esthetic appearance of such bridges compares well with through arches. The great difficulty of inspecting the anchorages of suspension bridges must be considered as a particularly critical condition, and this difficulty, together with the financial question, are two of the principal reasons why suspension bridges find such a limited application in Germany.

Mr. Krohn. R. KROHN,† ESQ. (by letter).—One can readily agree with Mr.

---

* Karlsrube, Germany.

† Geheimer-Regierungsrat, Danzig, Germany.

Mr. Krohn.

Grimm's interesting expositions when he states that, for long spans, the arch rib is in many cases superior to all other forms of trusses with respect to economy and esthetic effect; but the writer does not believe that this superiority exists in all cases.

The required tonnage of steel is not alone the guide in judging the economy. It is true that the costs of a bridge are essentially dependent on the tonnage of the superstructure, so that this quantity forms an important part in the determination of economy, but the erection costs must also be considered, and these are not the same for all trusses and under all circumstances. The erection costs may be least for a suspension bridge; in another case they may be least for a cantilever or an arch bridge; and the differences may be so large that the extra costs for a greater tonnage are not only balanced, but possibly the bridge with a greater tonnage may prove to be less expensive. Just as important, or perhaps more so, are the costs of the piers and abutments, which Mr. Grimm does not consider. The difference in these costs may be so large that a comparison between different bridges with respect to economy is disturbed. Assuming a very poor soil, an arch of long span, and the hinges at a very high elevation, the safety of the abutments may cause their cost to be essentially higher than that of the superstructure. In aiming at a reduction of the total costs, under such circumstances, one would not use arch ribs, and, apart from that, the consideration of the safety of the structure would lead one to select a bridge with vertical reactions. The writer is in perfect agreement with the view that the arched rib is in many cases very advantageous, for example, when the rise of the arch is comparatively great, as in the Aar Bridge, in Bern, the Garabit Viaduct, across the Truyère, and others.

The writer also thoroughly endorses the author's statements in reference to the beauty of arched ribs. There is no doubt that the arched rib, in esthetic respects, is preferable to all other trusses, and its effect is grander and more powerful than that of suspension bridges; but one must not go so far as to designate all arch bridges beautiful, for Bridge *C*, according to the writer's taste, is hardly satisfactory.

All these objections, however, cannot detract from the importance of Mr. Grimm's expositions, which consist in pointing out the great excellencies of arch bridges from the viewpoint of economy and esthetics.

The writer is a convinced adherent of arched ribs, and has used them in his most important bridges, namely, the Rhine Bridges at Bonn and Düsseldorf, the bridge across the Baltic Sea Canal at Levensan, and the Aar Bridge in Bern.

It is to be hoped that this interesting subject, now up for discussion, will be instrumental in opening a greater field of application for arched ribs of long spans, in accordance with their excellent features.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

EDMUND DORMAN LIBBY, M. Am. Soc. C. E.*

DIED APRIL 24TH, 1903.

Edmund Dorman Libby was born in Lyman, Me., on November 1st, 1851. He received his early education at the public schools of Jaffrey, N. H., to which place his parents had removed in 1867. In 1875 he was graduated from Kimball Union Academy, at Meriden. After his graduation from Dartmouth College, with the degree of A. B. in 1879, he entered the Thayer School, and in 1882 received his degree as Civil Engineer.

As a student in the Thayer School, Mr. Libby was unusually mature for his years. With a classmate he mastered the contents of Church's "Descriptive Geometry" within a few weeks of his entrance examinations, and passed a searching examination in the subject.

During his first vacation Mr. Libby was employed as Inspector of dredging on harbor work under the charge of a United States Engineer Officer, and discharged the duties so faithfully that he received the maximum pay allowed for such service. After his graduation in 1882 he entered the employ of the Government as Assistant Engineer on the Mississippi River improvement, with headquarters at St. Louis, Mo.

In 1887 he left the Government service to enter the employ of the Edgemoor Bridge and Iron Company, of Wilmington, Del., where he remained for one year. In 1889, he entered the service of the New York, New Haven and Hartford Railroad Company, with headquarters at Providence, R. I. He remained with this company until 1894, when he returned to the Government Service and was appointed Assistant Engineer on the works for the improvement of the Mississippi River, below St. Louis, which were being done under the direction of the United States Engineer Office. While in this position Mr. Libby had, for some years, responsible charge of the extensive operations for shore protection and regulation of the channel by dikes, mattresses, etc., and commanded large forces of men, towboats, barges, etc.

In November, 1901, Mr. Libby was obliged to give up his work on account of failing health. He spent that winter in Denver, Colo., hoping that the change of climate would prove beneficial. This hope was not realized, however, and in June, 1902, he returned to Concord, N. H., where he died on April 24th, 1903.

In June, 1887, Mr. Libby was married to Miss Emma O. Curtice, of Concord, N. H., who died in 1902. He was a Knight Templar, a

---

* Memoir prepared by the Secretary from papers on file at the House of the Society.

Member of the Ancient Order of United Workmen, and of the Independent Order of Redmen.

In a brief summary of some personal reminiscences by an associate on the Mississippi River work, it is stated that Mr. Libby was a very reserved man, working at times all day without exchanging a word with others in the same office. He was careful and conscientious almost to excess, working overtime and late into the night in order to accomplish work which he would not entrust to others. He was an excellent draftsman and a skilled mechanic, and owned a large and valuable collection of fine tools of various sizes and styles, which afterward found a ready sale at appraised value.

Mr. Libby was elected a Member of the American Society of Civil Engineers on May 6th, 1885.

THOMAS McKEOWN, M. Am. Soc. C. E.*

DIED JUNE 7TH, 1904.

Thomas McKeown was born in Southampton, England, in 1844. He was taught surveying, leveling, and drawing on the Ordnance Survey of Great Britain, at Southampton. From 1864 to 1869 he was engaged, as a subordinate, in making surveys and plans of defensive positions in Canada for the Imperial Government. He was then employed on the construction of the Wellington, Grey, and Bruce Railroad, as Assistant Engineer, from June, 1871, to December, 1872, when he was made Resident Engineer in local charge of the work until December, 1873. During part of this time (1870 to May, 1871), he was also engaged on surveys and plans of the City of Montreal for municipal and insurance purposes.

For six months in 1874 Mr. McKeown was Assistant Engineer on location for the Hamilton and North Western Railway. From January to May, 1875, he located the entire line (70 miles) of the London, Huron, and Bruce Railway, running through a difficult country. He was then appointed Resident Engineer on the construction of the last 18 miles of this road where he remained until December, 1875.

In January, 1876, he was appointed Chief Engineer of the Hamilton and North Western Railway, which position he retained until 1881, directing the location of the various sections, and having charge of the maintenance of way, until the road was completed in 1879. From 1879 to 1881 he was in entire charge of the maintenance of way.

In 1881 and 1882, Mr. McKeown was General Superintendent of the Detroit, Mackinac, and Marquette Railroad, and from January to

---

* Memoir prepared by the Secretary from information furnished by W. A. Haven, M. Am. Soc. C. E., and from papers on file at the House of the Society.

September, 1883, he was engaged as Contractor on the construction of the Marquette, Houghton, and Ontonagon Railroad.

In 1884, he went to England, and, until 1890, traveled extensively there and in France. On his return to the United States in 1890, he settled in Buffalo, N. Y., where he engaged in the retail trade of contractors' supplies, etc.

Mr. McKeown became a member of the firm of McKeown and Stowell, which, in 1891-1893, built the Norwalk Avenue and other large sewers in Buffalo. In payment for this work, the firm was obliged to take sewer bonds, which it had to discount at from 25% to 30%, and was compelled to make an assignment.

The next two years (1894-1896) were spent by Mr. McKeown in surveying and in building small sewers. He then became a member of the firm of Smith and McKeown, and, in 1897-1898, built the substructure of the Chicago Street Viaduct. On the death of Mr. Smith, in 1898, the finances of the firm were left in such shape as to embarrass Mr. McKeown seriously. From 1899 to 1902, he was engaged in the construction of sewers and cement walks. In 1902 the firm of McKeown and Johnson was organized, and, during 1902-1904, built the substructures of the Louisiana Street Viaduct, the Perry Street Viaduct, the South Buffalo sewer, and the Lockport Bridge.

On June 2d, 1904, Mr. McKeown contracted pneumonia, and died at his home in Buffalo, N. Y., five days later.

In 1884 Mr. McKeown was married to Miss Mary E. Tempany of London, England. He is survived by his wife and three daughters.

Mr. McKeown was elected a Member of the American Society of Civil Engineers on December 3d, 1879.

JOHN JAY McVEAN, M. Am. Soc. C. E.*

Died August 21st, 1910.

John Jay McVean was born at Darien, Genesee County, N. Y., on June 13th, 1850. He was the second son of John and Isabella McVean, and a descendant in direct line from the Clan McVean of Scotland.

His early education was received in the public schools and at the Free Academy of Rochester, N. Y., and the Rural Seminary at East Pembroke, N. Y. In the fall of 1869 he entered Cornell University, where he studied for three years.

Mr. McVean began his engineering work in the summer of 1872 on the survey for the Rochester and State Line Railroad, and he remained with this Company until the work was stopped by the panic of 1873. During the greater part of 1874 he was Assistant Engineer for the Erie Railroad, on second-track work between Hornellsville and Corning, N. Y. In 1875 he was employed as Assistant Engineer on the location and construction of the Rochester, Hornellsville and Pine Creek Railway. In 1876 he went to Michigan and served two years as City Engineer of Lansing. In 1878 he entered the service of the Detroit, Lansing and Northern Railroad, of which road he was made Chief Engineer in 1881. In 1889, he was also appointed Chief Engineer of the Chicago and West Michigan Railway.

---

* Memoir prepared by Job Tuthill, M. Am. Soc. C. E.

Mr. McVean held these positions until 1900, when failing health obliged him to give up active work. Partially recovering his health in 1905, he engaged, until his last illness, in consulting practice in his home city, Grand Rapids, Mich. In 1909 he was chosen by that municipality and the railroads concerned, to prepare plans for a comprehensive system of grade separation throughout the city.

Mr. McVean was an able executive, an engineer who combined theory with common sense, a man of sterling integrity and lovable disposition, and a chief under whom loyal service was a pleasure.

During the last twelve years of his life, Mr. McVean suffered intensely and constantly from arthritis, but bore his affliction with a courage and patient endurance rarely seen.

In 1879, he married Miss Rachel Shankland at Ellicottville, N. Y., who, with a son and a married daughter, survives him.

Mr. McVean was elected a Member of the American Society of Civil Engineers on September 3d, 1884, and served as a Director of the Society from 1898 to 1900. He was also a Member of the Western Society of Engineers, and of the American Railway Engineering and Maintenance of Way Association, and, from 1894 to 1897, he served as a Member of the Board of Public Works of Grand Rapids, Mich.

JAMES EAGER WILLARD, M. Am. Soc. C. E.*

Died March 8th, 1909.

James Eager Willard was born at Lowville, N. Y., on June 3d, 1832. He was educated in the local schools and at Lowville Academy.

He began his career as an engineer at the early age of seventeen, on the Black River and Erie Canals, on which he was engaged from 1849 to 1852, successively as Rodman, Draftsman, and Assistant Engineer. During this time, and while yet a very young man, he had responsible charge of important construction work, such as locks, aqueducts, culverts, bridges, and three reservoirs for feeding the Eastern Division of the Erie Canal. During the following two years,

---

* Memoir prepared by Samuel Whinery, M. Am. Soc. C. E.

1853 and 1854, he was engaged on the location and construction of the Utica and Black River Railroad, first as Transitman on location, and later as Division Engineer on the construction of 30 miles of the road.

In 1855 Mr. Willard re-entered the service of New York State and was engaged on canal work, serving for two years as Principal Assistant Engineer on the construction of the Black River Reservoir. In 1858 he was appointed a Resident Engineer on the Minneapolis and Cedar Valley Railroad.

From 1859 to 1871 Mr. Willard was engaged first in the banking and real estate business, and then in his father's extensive woolen mills, and other branches of manufacturing. His tastes, however, inclined him to return to engineering, and, in 1872, he accepted the position of Principal Assistant Engineer in charge of surveys for the Lake Erie, Evansville, and Southwestern Railroad.

Returning to the New York State Canal work, he was, in 1873 and 1874, Assistant Engineer in charge of the construction of locks at West Troy and Cohoes. After this he was interested, for about a year, in railroad contract work on the Cincinnati Southern Railroad, in Kentucky.

In the spring of 1875 Mr. Willard became Resident Engineer on the Cincinnati Southern Railroad, in charge of the construction of the foundations and masonry for the bridges over the Tennessee and South Chickamauga Rivers, and of other construction work, near Chattanooga, Tenn. This work was completed in 1876.

From 1877 to 1883 he was engaged, as U. S. Assistant Engineer, in charge of river improvement work, first at Colbert and Muscle Shoals, Tennessee River, under the direction of Major W. R. King, U. S. Engineer Corps, the work being on a large scale and done under the direct or hired labor system. Later, he was engaged on the improvement of the Mississippi River, at Carolina Bend, La., under the direction of Major W. L. Marshall, lately retired as Brigadier-General and Chief of Engineers, U. S. A.

Resigning from the Government service in 1883, Mr. Willard, as Manager for the contractors, constructed the substructure for the bridge over the Ohio River at Henderson, Ky., involving pneumatic foundations. After the completion of that work he was employed, for a few months (1885), in installing a plant for tunnel work on the New Croton Aqueduct. During the same year he became a member of the firm of Sooysmith and Company, having direct charge of the field work of the firm for about six years. During this period a number of important bridges were constructed under his direction, among which may be mentioned that across the Mississippi River, at Keithsburg, for the Iowa Central Railroad; the foundations for the Burlington and Northern Bridge at Prairie Du Chien; the foundations for the Chicago, Milwaukee and St. Paul Railroad Bridge over the Missouri River at Kansas City; the bridge over the Mississippi River at Fort Madison, for the Atchison, Topeka and Santa Fe Railroad; the bridge at Sibley over the Missouri River; three bridges over the Ohio, two at Cincinnati and one at Louisville; and a bridge over Salt River at West Point, Ky.

After severing his connection with Sooysmith and Company, Mr. Willard went to Portland, Ore., and built the substructure of the bridge over the Willamette River, which involved difficult work, including the cutting off of the piles for the pivot pier 70 ft. below water surface. Shortly after this the firm of Willard and Cornwall, Contractors, was organized, and under Mr. Willard's direction, built the substructures for three bridges for the Atchison, Topeka and Santa Fe Railroad over the South Canadian and Cimmaron Rivers; one at Little Rock, Ark., with pneumatic foundations; one over the Illinois River at Pekin, Ill.; one over the Scioto River at Chillicothe, Ohio; and the Grays Ferry Bridge, at Philadelphia, the latter being completed in 1898. Most of these structures involved pneumatic work, and Mr. Willard, by reason of his natural abilities and experience, became recognized as an expert in that department of engineering work.

In 1900 and 1901 his firm constructed, by contract, Lock No. 4 on the Black Warrior River, in Alabama, and after this work was completed, the firm seems to have been dissolved.

In 1903 Mr. Willard was engaged, as Resident Engineer, on the construction of a timber-treating plant at Granada, Miss., for which Walter W. Curtis, M. Am. Soc. C. E., was Chief Engineer. The work, which cost about $225 000, was done by the day-labor method, under Mr. Willard's immediate direction.

From 1904 to 1906, he was engaged, as U. S. Assistant Engineer, on the construction of Lock and Dam No. 6 on Green River, Kentucky, under the direction of Captain (now Major) H. Burgess, M. Am. Soc. C. E. Soon after this Mr. Willard engaged, with his son, in the lumber business in St. Louis, Mo., where he died on March 8th, 1909.

While Mr. Willard had not the advantage of an engineering education, he was able to attain, by study, hard work, and close application, a very creditable position in his profession. He possessed unusual executive ability, which fact, no doubt, led him into the field of contracting, where he was very successful in handling difficult work. One of his associates in some of these business enterprises, a Member of this Society, writes: "Mr. Willard was an able business manager in construction work." Another Member of the Society says: "I considered him as representative of the best type of American contractors"; and a Past-President of the Society writes: "I grew to entertain a very high regard for Mr. Willard as an engineer possessing great skill, sound judgment, and integrity. * * * We found that we could entirely rely upon Mr. Willard to do the work thoroughly well, promptly, and to the best advantage." The writer can personally testify that, as an assistant on a large and rather difficult work requiring ability, care, accuracy, and close application, he was efficient, trustworthy, and absolutely loyal.

Of Mr. Willard's personal character those who knew him most intimately will be warmest in their praise. Modest, retiring, and gentle speaking, it required close acquaintance with him to appreciate the rugged and forceful traits of character which lay beneath the surface, ready for action when occasion required. He was a good man, a good husband and father, a good friend, and a good engineer.

On June 29th, 1859, Mr. Willard was married to Margaret A. Brayton, whose death occurred several years previous to that of Mr. Willard.

Mr. Willard was elected a Member of the American Society of Civil Engineers on May 1st, 1899.

ROGER BROOKE IRWIN, Assoc. M. Am. Soc. C. E.*

Died May 23d, 1910.

Roger Brooke Irwin was born at Westminster, Md., on March 13th, 1884. He was the son of the late Patrick H. Irwin, at one time Chief Engineer of the Baltimore and Ohio Railroad. Mr. Irwin received his early education in the public schools of Westminster, and was graduated at Mount St. Joseph's College with the degree of B. S., in 1901.

Upon graduation, he began his engineering career on the construction of the Roxborough Filtration Plant, at Philadelphia, Pa. Later he entered the employ of the Baltimore and Ohio Railroad Company on survey and construction work. He remained with this company, in various capacities, until October, 1903, when he became an Assistant Engineer for the Western Maryland Railroad and was placed in charge of the construction of coal and freight piers at Port Covington, Md., and hay sheds and coal yards at Hillen Station, Baltimore, Md. Later he was in full charge of the reconstruction of bridges. He severed his connection with this company in March, 1907. From March, 1907, to March, 1908, he was the senior member of the firm of Irwin and Case, General Contractors for a large amount of plain and reinforced concrete construction for the Baltimore and Ohio Railroad. During this time, Mr. Irwin was also City Engineer of Westminster.

---

* Memoir prepared by W. W. Crosby, M. Am. Soc. C. E.

From October, 1908, to May, 1910, he was employed as Chief of Party for the State Roads Commission of Maryland, in charge of survey work. He resigned this position to accept that of Road Engineer of Cecil County, which he held at the time of his death, on May 23d, 1910, at Elkton, Md.

Mr. Irwin was unmarried, and is survived by two brothers and two sisters. He was an able, energetic, and efficient engineer, and a man of strong character, with the highest ideals of courtesy, honor, and integrity. His disposition was such, that he made friends wherever he went. He had the confidence and esteem of all who came in contact with him. He was thoroughly proficient in his work, and, had not death so suddenly cut short his career, his continued success and an honored position in his profession were assured.

Mr. Irwin was elected an Associate Member of the American Society of Civil Engineers on May 3d, 1910.

SILAS GILDERSLEEVE COMFORT, Assoc. Am. Soc. C. E.*

Died July 13th, 1910.

Silas Gildersleeve Comfort was born at Triangle, Broome County, N. Y., on April 27th, 1863. He was the son of the Reverend Silas Comfort, D. D., a prominent Methodist clergyman, and Sarah Ann Foster Comfort.

On his father's side, Colonel Comfort was descended from Robert Comfort who, with two brothers, came to this country from England. His great-great-grandfather, Robert Comfort, the son of the first Robert Comfort, married Elizabeth Betts, daughter of Captain Richard Betts and Mercy Whitehead Betts (the Hicksite ·Quakeress), of Newtown, L. I., whose family was prominent in the settlement of Long Island. His great-grandfather, Richard Comfort, served in both the Nester and Dutchess County Militias during the Revolutionary War, and his grandfather, John Comfort, who was a prominent merchant, built the Delaware-Susquehanna Division of the National Road, between the Hudson River and Lake Erie, which was afterward made the route of the Erie Railroad.

His parents died when he was about six years old, and he was reared by his half-brother, George Fisk Comfort, an eminent scholar, art critic, and author, and his wife, Anna A. Manning Comfort, a prominent physician and writer. Dr. Comfort gave him all the available advantages of education, treating him as a son. He was tutored by his half-brothers, and studied at private and public schools and at Syracuse University, from which he was graduated, receiving, in 1882, the degree of B. C. E. from the College of Liberal Arts, and, in 1884, the degree of B. Ar. from the College of Fine Arts. In 1887, he received the first Master's degree in architecture (M. Ar.) ever given by an institution in America.

---

* Memoir prepared by St. George H. Cooke, Assoc. M. Am. Soc. C. E.

During his college vacations Colonel Comfort had charge, for a time, of the construction work on the then new West Shore Railroad, between Utica and Savannah, N. Y., and was also employed by the Phœnix Iron Company, at Phœnixville, Pa., obtaining, in this way, much practical instruction before he was graduated. He had a special liking for the engineering of structural steel, of which he was a close student, and this fact, coupled with his unquestioned mathematical ability, rapidly advanced him in the estimation of the best engineers of that period.

In the summer of 1884 Colonel Comfort became Instructor in Mathematics and Technical Drawing at the Pennsylvania Military College (then the Pennsylvania Military Academy), at Chester, Pa. In 1887 he was appointed Professor of Architecture and Instructor in Civil Engineering and Technical Drawing, and in 1889, received the degree of C. E. from that institution. In 1892 he was made Professor of Engineering and Astronomy, and was appointed Captain and Adjutant of the College. In 1895, he was advanced to the position of Vice-President and was commissioned a Lieutenant-Colonel by the State of Pennsylvania.

At the time of his death, Colonel Comfort had been a faithful and efficient officer of the Pennsylvania Military College for twenty-six years, and graduates from the institution during that time remember with profit his plainly spoken words of advice.

During his residence in Chester, he designed much structural steel work, notably that for the Library of Yale University. The day before his death, he was appointed Consulting Engineer of the City of Chester, to supervise municipal work, the cost of which was estimated at more than $1 500 000.

Colonel Comfort was a Past-President of the Engineers' Club of Philadelphia; a Mason; and a Member of the American Geographical Society. He was also a Member of the Penn Club of Chester, President of the Board of Trustees of the Third Presbyterian Church, and a Member of the School Board, in which capacity he had served the city for a number of years, and was looked to for advice in regard to the school system of the municipality.

He was a Charter Member of the Sigma Psi Society which, later, became the Syracuse Chapter of the Phi Delta Theta Fraternity.

He is survived by his widow and two children, by a sister, Miss Grace M. Comfort, of New York City, and a half-brother, Melville Lane Comfort, of Monroe, Mich.

Colonel Comfort was elected an Associate of the American Society of Civil Engineers, on March 31st, 1891.

620.

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XXXVI—No. 10

DECEMBER, 1910

Edited by the Secretary, under the direction of the Committee on Publications.

Reprints from this publication, which is copyrighted, may be made on condition that the full title of Paper, name of Author, page reference, and date of presentation to the Society, are given.

CONTENTS

Society Affairs..........................Pages 529 to 576.
Papers and Discussions ....Pages 1559 to 1760.

NEW YORK 1910.

Entered according to Act of Congress, in the year 1910, by the American Society of Civil Engineers, in the office of the Librarian of Congress, at Washington.

American Society of Civil Engineers

OFFICERS FOR 1910

President, JOHN A. BENSEL

Vice-Presidents

Term expires January, 1911:	*Term expires January, 1912:*
GEORGE H. PEGRAM	JOHN T. FANNING
EMIL SWENSSON	HUNTER McDONALD

Secretary, CHARLES WARREN HUNT

Treasurer, JOSEPH M. KNAP

Directors

Term expires January, 1911:	*Term expires January, 1912:*	*Term expires January, 1913:*
CHARLES L. HARRISON	FRANCIS LEE STUART	WILLIAM E. BELKNAP
GEORGE W. KITTREDGE	SAMUEL C. THOMPSON	HORACE LOOMIS
DEXTER BRACKETT	WILLIAM G. WILKINS	GEORGE A. KIMBALL
HORACE ANDREWS	ARTHUR N. TALBOT	PERCIVAL ROBERTS, JR.
GARDNER S. WILLIAMS	WILLIAM M. GARDNER	CHARLES F. LOWETH
CHARLES S. CHURCHILL	HORACE A. SUMNER	ARTHUR DEWINT FOOTE

Assistant Secretary, T. J. McMINN

Standing Committees

(THE PRESIDENT OF THE SOCIETY IS *ex-officio* MEMBER OF ALL COMMITTEES)

On Finance:	*On Publications:*	*On Library:*
GEORGE H. PEGRAM	C. L. HARRISON	GEORGE W. KITTREDGE
CHARLES S. CHURCHILL	HORACE ANDREWS	DEXTER BRACKETT
GEORGE A. KIMBALL	WILLIAM E. BELKNAP	JOHN T. FANNING
HORACE LOOMIS	FRANCIS LEE STUART	HUNTER McDONALD
WILLIAM G. WILKINS	EMIL SWENSSON	CHAS. WARREN HUNT

Special Committees

ON UNIFORM TESTS OF CEMENT: George S. Webster, Richard L. Humphrey, George F. Swain, Alfred Noble, Louis C. Sabin, S. B. Newberry, Clifford Richardson, W. B. W. Howe, F. H. Lewis.

ON CONCRETE AND REINFORCED CONCRETE: C. C. Schneider, J. E. Greiner, W. K. Hatt, Olaf Hoff, Richard L. Humphrey, Robert W. Lesley, Emil Swensson, A. N. Talbot, Joseph R. Worcester.

ON ENGINEERING EDUCATION: Desmond FitzGerald, Benjamin M. Harrod, Onward Bates, D. W. Mead, Charles Hansel.

ON STEEL COLUMNS AND STRUTS: Austin L. Bowman, Alfred P. Boller, Emil Gerber, Charles F. Loweth, Ralph Modjeski, Frank C. Osborn, George H. Pegram, Lewis D. Rights, George F. Swain, Emil Swensson, Joseph R. Worcester.

ON BITUMINOUS MATERIALS FOR ROAD CONSTRUCTION: W. W. Crosby, A. W. Dean, H. K. Bishop, A. H. Blanchard.

◆

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

HOUSE OF THE SOCIETY—220 WEST FIFTY-SEVENTH STREET, NEW YORK.

TELEPHONE NUMBER.................5913 Columbus.
CABLE ADDRESS..................."Ceas, New York."

Vol. XXXVI. DECEMBER, 1910. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

SOCIETY AFFAIRS

CONTENTS

Minutes of Meetings: PAGE
Of the Society, November 16th and December 7th, 1910 ... 529
Of the Board of Direction, December 6th, 1910 ... 533
Announcements:
Hours during which the Society House is open ... 534
Future Meetings ... 534
Special Meetings for Topical Discussion ... 534
Proposed Amendment to the Constitution ... 535
Searches in the Library ... 536
Papers and Discussions ... 536
Subscription Price to the Publications of the Society ... 537
Local Associations of Members of the American Society of Civil Engineers ... 537
Privileges of Engineering Societies Extended to Members ... 538
Accessions to the Library:
Donations ... 541
By purchase ... 544
Membership (Additions, Deaths) ... 545
Recent Engineering Articles of Interest ... 549
Reports of Special Committees:
Progress Report of Special Committee on Bituminous Materials for Road Construction ... 569

MINUTES OF MEETINGS

OF THE SOCIETY

November 16th, 1910.—The meeting was called to order at 8.30 P. M.; A. L. Bowman, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 105 members and 15 guests.

A paper by H. H. Wadsworth, M. Am. Soc. C. E., entitled "The Failure of the Yuba River Débris Barrier, and the Efforts Made for Its Maintenance," was presented by the Secretary, who also read discussions on the subject by Messrs. William W. Harts and W. C. Hammatt. The paper was discussed orally by Messrs. T. C. Atwood and S. M. Purdy.

The Secretary announced the following deaths:

Stillman Williams Robinson, elected Member, January 2d, 1884; died October 31st, 1910.

Harold Lord, elected Junior, September 3d, 1907; died September 18th, 1910.

Arthur Keddie Macfarlane, elected Junior, October 5th, 1909; died November 2d, 1910.

George Higgins Myers, elected Junior, June 1st, 1909; died October 10th, 1910.

Adjourned.

December 7th, 1910.—The meeting was called to order at 8.30 P. M.; President Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, 120 members and 16 guests.

The minutes of the meetings of October 19th and November 2d, 1910, were approved as printed in *Proceedings* for November, 1910.

A paper by William Fry Scott, Assoc. M. Am. Soc. C. E., entitled "Bond-Friction-Resistance in Reinforced Concrete," was presented by the author. Written discussions by Messrs. Edward Godfrey, Joseph T. Maguire, and A. N. Talbot, were read by the Secretary, and the subject was discussed orally by Messrs. A. E. Lindau, E. P. Goodrich, and the author.

A paper by J. C. Stevens, Assoc. M. Am. Soc. C. E., entitled "Hydrography as an Aid to the Successful Operation of an Irrigation System," was presented by title. Written communications on the subject, by Messrs. E. F. Chandler, C. E. Shipman, and Clemens Herschel, were read by the Secretary.

The Secretary announced the election of the following candidates on December 6th, 1910:

As Members.

Paul Stanley Bond, Zamboanga, Philippine Islands.
Albert Clark Eddy, New Westminster, B. C., Canada.
Alfred Brooks Fry, New York City.
Joshua Wilson Richardson, Veracruz, Mexico.
Frederick Christian Woermann, San Antonio, Tex.

As Associate Members.

Raymond Cleaveland Allen, Manchester, Mass.
James Leland Averill, New York City.
Frank William Barnes, Jr., North Cambridge, Mass.
Charles Munnerlyn Binford, Riley, W. Va.
Arthur Pierson Clark, St. Louis, Mo.
Lawrence Everett Curfman, Pittsburg, Kans.
Warren French Day, Chicago, Ill.
William Grear Dow, Eden, Wyo.
Samuel Campbell Dunlop, Charleston, S. C.
Victor Edwin Ellstrom, St. Louis, Mo.

ELMER JOHN GASS, Tucson, Ariz.
HOWARD SPOONER GAY, Little Falls, N. Y.
CLARENCE GOLDSMITH, Lawrence, Mass.
LEE SWANEY GRISWOLD, San Francisco, Cal.
JOHN PAUL HEALY, Washington, D. C.
RALPH HERBERT HOSMER, Pequea Creek, Pa.
MARION REED KAYS, Richfield, Idaho.
CHARLES PATTERSON MCCAUSLAND, Baltimore, Md.
DUNCAN WILLIAM MCLACHLAN, Ottawa, Ont., Canada.
JOHN THOMPSON NEELY, Rowlesburg, W. Va.
RICHARD WOOD RANDOLPH, Canton, China.
CHARLES ANDREW RANDORF, Buffalo, N. Y.
JOHN ROBERT RICH, Bandy, Va.
CLIFFORD SEAVER, New York City.
CHARLES ENGLISH SHEARER, Memphis, Tenn.
EDWARD SHEPPARD SMITH, Gooding, Idaho.
JOHN RODGERS SPELMAN, New York City.
OTHO WILLIAM STILES, Circleville, Ohio.
FREDERICK WINEMAN STRICKLER, Lincoln, Nebr.
WARREN G SWENDSEN, Boise, Idaho.
CHARLES HOOK TOMPKINS, Washington, D. C.
ENRIQUE RUIZ WILLIAMS, Sagua la Grande, Cuba.

AS JUNIORS.

NED DUNCAN BAKER, Sacramento, Cal.
EMMETT RAYMOND BRANN, Cainsville, Mo.
LYNN CRANDALL, Salt Lake City, Utah.
WARREN ELLIS DAY, Oakdale, Cal.
ADOLPHUS JAMES EDDY, Berkeley, Cal.
BURTNER FLEEGER, Wilkinsburg, Pa.
ARTHUR WILLIAM HARRINGTON, Watertown, N. Y.
WILLIAM WESTERFIELD HAVENS, New York City.
CLIFTON EWING HICKOK, Portland, Ore.
DANIEL HUBBARD, Valencia, Pa.
NORMAN HUGHES, Atlanta, Ga.
HENRY JAMES KESNER, Berkeley, Cal.
ALBERT PREISACH LEARNED, Lawrence, Kans.
ALEXANDER SYDNEY LYNCH, West Haven, Conn.
WILLIAM MENKE, White Plains, N. Y.
WALTER SMYTH MOORE, Louisville, Ky.
THEODORE NAGEL, Pittsburg, Pa.
RUBLE ISAAC POOLE, West Raleigh, N. C.
LEWIS RUFFNER SMITH, JR., Wellington, Wash.
AUSTIN RUSSELL WILLARD SPERRY, Berkeley, Cal.
EDWARD WALTER WALL, Providence, R. I.

The Secretary announced the transfer of the following candidates on December 6th, 1910:

FROM ASSOCIATE MEMBER TO MEMBER.

ALEXANDER FLOYD ARMSTRONG, Albany, N. Y.
MURRAY BLANCHARD, New York City.
VICTOR HUGO COCHRANE, Kansas City, Mo.
EDWARD GRAY, St. Louis, Mo.
ALLEN BOYER MCDANIEL, Vermilion, S. Dak.
THADDEUS MERRIMAN, New York City.
HAROLD ASHTON PARSONS, Stamford, Conn.
JULIUS WELCH PFAU, New York City.
WALTHER RASTER, Chicago, Ill.
GEORGE LOOMIS ROBINSON, New York City.

FROM JUNIOR TO ASSOCIATE MEMBER.

HUNLEY ABBOTT, New York City.
HAROLD DAYTON ALLEN, Newark, N. J.
ROBERT EDWARD BARRETT, New York City.
WALTER ELLIOTT BURNS, Sacramento, Cal.
ERLE LONG COPE, Berkeley, Cal.
GUILLERMO GUSTAVO FISCHER, Santa Clara, Cuba.
WILLIAM LAWRENCE HANAVAN, Newburg, N. Y.
HOWARD BENSON WILBERFORCE HOWIE, Chattanooga, Tenn.
JOHN MARIE THOMAS RICE, Pittsburg, Pa.
JOHN KUHN SCOTT, Pittsburg, Pa.
ADONIRAM JUDSON WARLOW, Bethlehem, Pa.

The Secretary announced the following deaths:

OCTAVE CHANUTE, Past-President, Am. Soc. C. E., elected Member, February 19th, 1868; Fellow, July 11th, 1872; died November 23d, 1910.

GEORGE SHREVE WILKINS, elected Junior, October 4th, 1892; Associate Member, October 5th, 1898; died August 17th, 1910.

Adjourned.

December 21st, 1910.—Because of the necessity of going to press with this number of *Proceedings* in advance of this meeting, the publication of its minutes must be deferred until January, 1911. Two papers have been set down for discussion: "Notes on the Bar Harbors at the Entrances to Coos Bay, and Umpqua and Siuslaw Rivers, Oregon," by Morton L. Tower, M. Am. Soc. C. E.; and "Timber Preservation, Its Development and Present Scope," by Walter Buehler, M. Am. Soc. C. E.

OF THE BOARD OF DIRECTION

(Abstract)

December 6th, 1910.—President Bensel in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Andrews, Belknap, Brackett, Kimball, Kittredge, Knap, Pegram, Schneider, Swensson, and Thompson.

Arrangements for a proposed trip to Panama for members of the Society were reported upon, and the Secretary was authorized to issue a circular to all members giving the full details in regard to the matter.

A draft of a proposed bill for the licensing of Civil Engineers was considered.

Ballots for membership were canvassed, resulting in the election of 5 Members, 32 Associate Members, and 21 Juniors, and the transfer of 11 Juniors to the grade of Associate Member.

10 Associate Members were transferred to the grade of Member.

Applications were considered and other routine business transacted.

Adjourned.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

January 4th, 1911.—8.30 P. M.—A paper entitled "The Valuation of Public Service Corporation Property," by Henry Earle Riggs, M. Am. Soc. C. E., will be presented for discussion.

This paper was printed in *Proceedings* for November, 1910.

Wednesday and Thursday, January 18th and 19th, 1911.—The Fifty-eighth Annual Meeting will be held. The Business Meeting will be called to order at 10 o'clock on Wednesday morning at the Society House. The Annual Reports will be presented, officers for the ensuing year elected, members of the Nominating Committee appointed, Reports of Special Committees presented for discussion, a proposed Amendment to the Constitution presented for action, and other business transacted.

Arrangements for the Annual Meeting have been placed in the hands of a committee composed of Messrs. George H. Blakeley, F. R. Harris, and Chas. Warren Hunt.

February 1st, 1911.—8.30 P. M.—At this meeting a paper entitled "The Water-Works and Sewerage of Monterrey, N. L., Mexico," by George Robert Graham Conway, M. Am. Soc. C. E., will be presented for discussion.

This paper is printed in this number of *Proceedings.*

February 15th, 1911.—8.30 P. M.—A paper by E. D. Hardy, M. Am. Soc. C. E., entitled "Water Purification Plant, Washington, D. C., Results of Operation," will be presented for discussion.

This paper is printed in this number of *Proceedings.*

SPECIAL MEETINGS FOR TOPICAL DISCUSSION

On the two days immediately following the Annual Meeting, three meetings of the Society will be held at which the subject for discussion will be "Road Construction and Maintenance."

The meetings will be held as follows:

First Meeting, Friday, January 20th, 1911.—10 A. M.—Three subdivisions of the subject will be discussed:

(1) "Preliminary Investigations."

The discussion on this subject will be introduced by Logan W. Page, M. Am. Soc. C. E.

(2) "Relative Value of Three Methods of Carrying on Work: (*a*) That in which both labor and material are furnished by the contractor. (*b*) That in which the material is supplied by the party of the first part, and the labor by the contractor. (*c*) That in which both the labor and material are supplied by the party of the first part."

The discussion on this subject will be introduced by Harold Parker, M. Am. Soc. C. E.

(3) "Systems of Maintenance."

The opening discussion on this subject will be by Hubert K. Bishop, M. Am. Soc. C. E.

Second Meeting Friday, January 20th.—2 P. M.—The following sub-divisions of the subject will be discussed:

(4) "The Use of Water, Calcium Chloride, Light Oils, etc., as Dust Palliatives."

This subject will be introduced by Samuel Whinery, M. Am. Soc. C. E.

(5) "Surface Treatment with Tars, Heavy Oils, etc."

The discussion on this subject will be introduced by Charles W. Ross, Esq.

Third Meeting, Saturday, January 21st.—10 A. M.—The following topics will be introduced:

(6) "The Use of Bituminous Materials by Penetration Methods."

The discussion on this subject will be introduced by Walter W. Crosby, M. Am. Soc. C. E.

(7) "The Use of Bituminous Materials by Mixing Methods."

This topic will be introduced by Arthur H. Blanchard, M. Am. Soc. C. E.

A number of Engineers specially interested in Road Construction have agreed to be present and to take part in the discussion of each of these topics, and it is the intention to afford an opportunity to all who attend the meetings to present their opinions. With this end in view, each participant in the discussion of each topic is to be limited to five minutes, except the speakers who introduce the subject, and ten minutes are allotted to them.

All Engineers, whether members of the Society or not, are cordially invited to attend these meetings, and it is hoped that the resulting discussion when collated and published will bring the whole subject up to date.

PROPOSED AMENDMENT TO THE CONSTITUTION

The following proposed amendment to the Constitution was received on the first Wednesday in November, 1910, and is herewith brought to the attention of all Corporate Members.

This amendment will be presented to the Annual Meeting, January 18th, 1911, as provided in Section 2 of Article IX of the Constitution, which reads as follows:

"2. Amendments presented to the Secretary on or before the first Wednesday in November shall be sent by letter to the several Corporate Members of the Society at least twenty-five days previous to the Annual

Meeting. Such amendments shall be in order for discussion at such Annual Meeting, and may be amended in any manner pertinent to the original amendments by a majority vote of the Annual Meeting, and if so amended shall be voted upon by letter-ballot in form as amended by the Annual Meeting; if not so amended, they shall be voted upon by letter-ballot as submitted. The vote to be counted at the first regular meeting in March."

Amend Article IV, as follows:

Add at the end of Article IV, the following:

"13. Corporate Members and Associates who have reached the age of seventy years, and who have paid dues as such for twenty-five years, shall be exempt from further dues. Corporate Members and Associates who have paid dues as such for thirty-five years shall be exempt from further dues."

The above amendment is signed by the following Corporate Members: Kenneth Allen, A. L. Bowman, F. W. Gardiner, J. A. Knighton, C. D. Pollock, Robert Ridgway, J. Waldo Smith, and Geo. W. Tillson.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendix* to the Annual Report of the Board of Direction for the year ending December 31st, 1906, contains a summary of all searches made to that date.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussion of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings.* The issue of volumes of *Transactions* is dependent on the closing of discussions, and the co-operation of the membership in this matter is essential to the regular issue of each quarterly volume.

---

* *Proceedings*, Vol. XXXIII, p. 20 (January, 1907).

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussions, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

SUBSCRIPTION PRICE TO THE PUBLICATIONS OF THE SOCIETY

The following subscription rates have been fixed by the Board of Direction for the publications of the Society:

Proceedings, ten Numbers per annum, $8. Price for single numbers, $1.

Transactions, four Volumes per annum, $12. Price for single volumes, $4.

On the above prices there is a discount of 25% to members who desire extra copies of any of these publications, to Libraries, and to Book-dealers.

There is also an additional charge per annum, to cover foreign postage, of 75 cents for *Proceedings* and $1 for *Transactions,* or 8 cents and 25 cents, respectively, for single numbers.

A special subscription rate has been fixed by the Board for the *Proceedings* of the Society for the benefit of Students in Technical Schools. This rate is $4.50 per annum, and is available to any *bona fide* student of any technical school.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Friday of February, April, June, August, October, November, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., Assoc. M. Am. Soc. C. E., 713 Mechanics' Institute, 57 Post Street.

The by-laws of the Association provide for the extension of hospitality to any members of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest of the Association at any of the above meetings, if he will notify the Secretary that he is in San Francisco.

Colorado Association

(Abstract of Minutes of Meeting)

November 15th, 1910.—The November meeting of the Association took the form of an excursion to Cañon City, Colo., and vicinity. After an inspection of the construction work of the dam of the Beaver Land and Irrigation Company, the party returned to Cañon City where dinner was served.

Following the dinner the meeting was called to order; President George G. Anderson in the chair; H. J. Burt, Secretary; and present, also, 20 members and 11 guests.

The minutes of the October meeting were read and approved.

A paper on the Construction of the Beaver Dam was presented by Winfield Holbrook, Assoc. M. Am. Soc. C. E., Resident Engineer, which was followed by a discussion of the subject.

W. C. Wetherill, M. Am. Soc. C. E., Consulting Engineer of the Empire Zinc Company, gave an informal talk on zinc, its occurrence in ores, its reduction, and uses, which was followed by a description of the methods used by the Empire Zinc Company at its Cañon City plant, by A. R. Livingston, M. Am. Soc. C. E., the Superintendent. Questions and discussions on this subject followed.

A resolution of thanks was unanimously voted to all who had extended courtesies to the members of the Association on the trip.

Adjourned.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

Architekten=Verein zu Berlin, Wilhelmstrasse 92, Berlin W. 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, 718 Caxton Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Colorado Association of Members, Am. Soc. C. E., H. J. Burt, Secy., 235 Equitable Building, Denver, Colo.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 2511 Oliver Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur- und Architekten-Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur- und Architekten-Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill

ACCESSIONS TO THE LIBRARY

(From November 8th to December 12th, 1910)

DONATIONS*

DER TALSPERRENBAU

Nebst Beschreibung Ausgeführter Talsperren. Von P Ziegler. Zweite Vollständig Neubearbeitete Auflage. Paper, 11 x 7 in., 12 + 392 pp., illus. Berlin, Wilhelm Ernst & Sohn, 1911. 21.50 Marks.

This book contains, it is stated, a detailed study of the construction of dams, from choice of site to completion. In this, the second edition, the historical and otherwise prominent characteristics of such construction have been described, but only those details which are necessary to establish general principles and rules, have been given as examples. A description of completed dams, which includes several constructed in the United States, is given, and the book also contains a bibliography of the subject. The Contents are: Die Vorarbeiten; Die Bauart des Abschlusswerks: Entnahmevorrichtungen und Hochwasserüberfälle; Die Berechnung der Staumauern; Beschreibung einiger bemerkswerten Talsperrenanlagen; Die Zerstörung von Talsperren und ihre Ursachen; Gesetzliche Bestimmungen; Anhang: Literaturverzeichnis; Angaben über deutsche und österreichische Talsperren.

TRACK FORMULÆ AND TABLES.

A Handbook of the Theory and Practice of Turnouts and Track Connections, with Useful Tables, Original and Selected, for the Use of Students and Engineers in the Classroom, Office and Field. By Shelby Saufley Roberts, M. Am. Soc. C. E. Leather, 7 x 4 in., illus., 14 + 514 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1910. $3.00.

Assuming that the student, and the engineer entrusted with the design or staking out of tracks, will have acquired information in regard to the theory of railroad curves, the author, it is stated, has omitted all discussion of that subject. It has been his aim to present, in this book, in a practical manner, those track problems most frequently met in actual practice, and to these he has added time-saving tables and others for estimating. The formulas are said to be based on the actual properties of the frog and split switch, and as most of them have been worked out in the field, they have been tested in actual practice. The Contents are: Frogs and Split Switches; Turnouts into Diverging Tracks; Crossovers; Connecting Tracks; Wyes; Parallel and Concentric Sidings; Crossings; Ladder Tracks; Vertical Curves; Capitalization, Annual Cost, Equivalent Cost; Miscellaneous Formulæ and Rules of the Thumb; Tables.

CLARIFICATION OF SEWAGE.

By Rudolf Schmeitzner. Translated by A. Elliott Kimberly. Cloth, 7½ x 5 in., illus., 15 + 114 pp. New York, The Engineering News Publishing Company; London, Constable & Company, Ltd., 1910. $1.50.

This book is stated to be the result of a visit by the author to a number of the larger German clarification plants where preparatory devices constitute the entire treatment of sewage. The plants are discussed from an engineering standpoint, the chemical and bacterial phases of the question being but briefly mentioned, and the book is stated by the translator to be a critical review of the design of screens of various types of sedimentation tanks, of towers, and of methods of sludge removal and disposal at present in use in Germany. The Contents are: Introduction; General Principles of the Design of Clarification Plants; The Composition of Sewage; Component Parts of a Clarification Plant; Sludge Removal and Treatment for the Recovery of By-Products; Practical Arrangement of Clarification and Purification Plants; Addendum; List of Plates; Index.

---

* Unless otherwise specified, books in this list have been donated by the publishers.

THE ART OF ROADMAKING.

Treating of the Various Problems and Operations in the Construction and Maintenance of Roads, Streets, and Pavements. By Harwood Frost. Cloth, 9 x 6 in., illus., 17 + 544 pp. New York, The Engineering News Publishing Co., 1910. $3.00.

The preface states that this book is intended to give an outline of the history of road building, of the problems which confront the engineer in the location, construction, and maintenance of roads, and of the properties of the various roadmaking materials, in non-technical language suitable for the general reader. No originality as regards the contents or the presentation of new methods or ideas, is claimed, and in the compilation of the subject-matter technical periodicals, Government reports, and a few trade publications, have been drawn on and quoted, the object being to condense into a single volume the fundamental and essential principles of road-making as presented by the most reliable authorities. The book contains an extensive bibliography and a descriptive list of current books and pamphlets on the subject. The Contents are: Poem—"The Road;" Introduction; Part I, Preliminary Considerations: Resistances to Traction; Road and Pavement Economies; Principles Underlying the Selection of Pavements for Different Purposes. Part II, Country and Suburban Roads: Location of Country Roads; Construction and Protective Works; Material Used in Road Construction; Earth, Gravel, Sand and Clay Roads; Broken-Stone Roads; Roads in Mountainous Districts; Control and Prevention of Road Dust; State Aid Laws. Part III, City Streets and Pavements: The Design of City Streets; Stone Block Pavements; Brick Pavements; Wood Block Pavements; Asphalt Pavements; Concrete Pavements; The Cleaning and Santitation of City Streets; Sidewalks, Curbs, and Gutters; Miscellaneous Roads and Pavements; The Roadside; Appendix; Index.

THE THEORY AND PRACTICE OF SURVEYING.

Designed for the Use of Surveyors and Engineers Generally, but Especially for the Use of Students in Engineering. By J. B. Johnson. Seventeenth Edition, Rewritten by Leonard S. Smith, Assoc. M. Am. Soc. C. E. Cloth, 8 x 5½ in., illus., 32 + 921 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1910. $3.50.

The reviser, it is stated, has taken advantage of a needed resetting of this book to revise it thoroughly and in a large part to rewrite it, in order to carry out the author's plan "to keep this work fully abreast of the best American practice." The book is divided into three parts, of which Part I treats of the adjustment, use, and care of all kinds of instruments used in surveying, either in the field or office. The changes in this part, the reviser states, are as follows: The rearrangement of the subject-matter and the addition of illustrations and descriptions of various instruments. In Part II, which includes descriptions of the theory and practice of surveying methods, the chapters on Land Surveying, Topographical Surveying, Hydrographic Surveying, and City Surveying have been rewritten and brought up to date. The chapter on Railroad Topography has been omitted in this edition and in its place is a new chapter on Stream Measurements. A new article on the surveying of bore-holes has been added to the chapter on Mining Surveying, together with new problems on the subject and new illustrations. In Part III, which relates to Geodetic Surveying, the old chapter on that subject has been divided and rewritten in five chapters. There is also a new chapter on Field Astronomy by Professor George C. Comstock of the University of Wisconsin, and the chapter on Map Projection and Map Lettering has also been rewritten and enlarged. Another new feature is the addition, at the end of each chapter, of references to the best literature on the subject. The Contents are: Surveying Instruments: Instruments for Measuring Distances; Instruments for Determining Directions; Instruments for Determining Horizontal Lines; Instruments for Measuring Angles; The Plane Table; Additional Instruments Used in Surveying and Plotting. Surveying Methods: Land Surveying; Topographical Surveying by the Transit and Stadia; Hydrographic Surveying; Stream Measurement; Mining Surveying; City Surveying; The Measurement of Volumes. Geodetic Surveying: Triangulation and Base Line; Field Astronomy; Trigonometrical Levelling; Precise Spirit Levelling; Projection of Maps, Map Lettering, etc.; Appendices; Tables; Index.

PRACTICAL SHAFT SINKING.

By Francis Donaldson. Cloth, 9 x 6 in., illus., 7 + 143 pp. New York and London, McGraw-Hill Book Company, 1910. $2.00.

The subject-matter of this book is stated to have been published as a series of articles, in *Mines and Minerals* during 1909-10, and is here reproduced with alterations and additions. A shaft contract form in common use is appended to the first chapter, which relates to shafts and shaft sinking. This is followed by chapters on the plant required and methods used for sinking shafts in various surfaces. A description of the various kinds of sinking pumps is followed by a chapter on materials for lining shafts, other than concrete, to which subject the last chapter is devoted. The Contents are: Some Deep Shafts, Features of Contracts for Sinking, Form of Contract; Plant Required: Boilers, Hoisting Engines, Head-Frame and Bucket, Air Compressors; Sinking Through Surface—Soft Ground: Wooden Sheeting, Steel Sheeting, Caissons of Steel, Wood, or Concrete; Sinking Through Soft Ground: Pneumatic Process, Shield Method; Sinking in Rock; Arrangement of Holes, Tools and Methods Used in Drilling, Costs and Speed; The Sinking-Drum Process, Mammoth Pump, The Freezing Process; The Kind-Chaudron Boring Process, Cementation of Water-Bearing Fissures; Lifting Water, Horizontal *vs.* Vertical Pumps, Handling Pumps in Shaft, Cornish Pumps; Shaft Linings; Concrete Linings, Costs per Linear Foot for Rectangular, Elliptical, and Quadrilateral Shafts; Index.

TEXT-BOOK ON PRACTICAL ASTRONOMY.

By George L. Hosmer. Cloth, 9 x 6 in., illus., 11 + 205 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1910. $2.00.

It has been the author's intention, as stated in the preface, to produce a book which shall be intermediate between a student's textbook of Astronomy and Geodesy and the short chapter on the subject generally given in textbooks on Surveying, and which shall be especially adapted to the needs of the civil engineering student. The subject has been discussed from an engineering standpoint, and the observations treated of are stated to be chiefly those which can be made with surveying instruments. The elementary principles have been treated rather elaborately in order to make them clear, and much space has been devoted to the Measurement of Time, which subject is stated to cause the student more difficulty than any other branch of Practical Astronomy. The subject-matter has been arranged as a reference book for the field engineer, the more elementary subjects being printed in large type. The Chapter Headings are: The Celestial Sphere, Real and Apparent Motions; Definitions, Points and Circles of Reference; Systems of Coördinates on the Sphere; Relation Between Coördinates; Measurement of Time; The American Ephemeris and Nautical Almanac, Star Catalogues, Interpolation; The Earth's Figure, Corrections to Observed Altitudes; Description of Instruments, Observing; The Constellations; Observations for Latitude; Observations for Determining the Time; Observations for Longitude; Observations for Azimuth; Nautical Astronomy; Tables; Index.

Gifts have also been received from the following:

Aberdeen, Scotland-Water-Works. 1 vol. 2 pam.
Aldershot, England, Gas, Water & Dist. Lighting Co. 2 pam.
Am. Min. Congress. 10 pam.
Arnold, Bion J. 1 bound vol.
Birmingham, England-Water-Works. 5 pam.
Black, William M. 2 pam.
Blackpool, England-Water-Works. 3 pam.
Boston, Mass.-Dept. of Parks. 1 pam.
California-Board of State Harbor Commrs. 1 bound vol.
Cambridge, England-Univ. & Town Water-Works Co. 6 pam.
Cambridge, Mass.-City Engr. 1 pam.
Canada-Board of Ry. Commrs. 1 vol.
Canada-Dept. of Marine and Fisheries. 2 vol., 1 pam.
Canada-Geol. Survey. 1 pam.
Cape of Good Hope-Public Works Dept. 1 pam.
Cape Town, South Africa-Dept. of Irrig. 1 pam.
Cardiff, Wales-Water-Works. 1 pam.
Cheltenham, England-Water-Works. 1 pam.
Colorado, Univ. of. 1 vol.
Corthell, E. L. 23 pam.
Cuarto Congreso Cientifico (1. Pan-Americano). 1 vol.
Dartmouth Coll.-Thayer School of Eng. 2 pam.
Dist. of Columbia-Engr. Dept. 1 vol.
Dover, England-Water-Works. 1 pam.
Dunoon, Scotland-Water-Works. 1 pam.
East Indian Ry. Co. 1 pam.
Ecole Speciale D'Architecture. 1 pam.
Edinburgh, Scotland-Water-Works. 1 bound vol., 3 pam.
Exeter, England-City Engrs. and Surveyors. 2 pam.
Ferrocarriles Nacionales de México. 1 pam.
Great Britain-Port of London Authority. 2 pam.
Hartmann, Ernest F. 1 diagram.
Hering, Rudolph. 1 pam.
Howie, H. B. W. 1 pam.
Illinois-Bureau of Labor Statistics. 2 bound vol., 2 pam.
Illinois-R. R. and Warehouse Comm. 1 bound vol., 1 map.
Illinois, Univ. of-Eng. Exper. Station. 2 bound vol.
India-Public Works Dept. 1 pam.
Indian Midland Ry. Co. 1 pam.
Institution of Civ. Engrs. 1 bound vol., 1 pam.
Institution of Engrs. and Shipbuilders in Scotland. 1 pam.
Iowa Central Ry. Co. 2 pam.

Iron and Steel Inst. 1 bound vol.
Jacksonville, Fla.-Board of Water-Works. 1 pam.
Leeds, England-Water-Works. 1 pam.
Leicester, England-Water-Works. 2 pam.
Lewis, N. P. 1 bound vol.
Lynn, Mass.-City Council. 1 bound vol.
McGill Univ. 3 bound vol.
Manchester, England-Water-Works. 5 pam., 3 maps.
Manchester Steam Users Assoc. 1 pam.
Margate, England-Water-Works. 3 pam., 1 bound vol.
Massachusetts - Charles River Basin Comm. 1 pam.
Master Car Builders' Assoc. 1 bound vol.
Mead, Charles A. 2 bound vol.
Michigan R. R. Comm. 1 bound vol.
Michigan, Univ. of. 1 pam.
Mississippi-Geol. Surv. 1 pam.
Montreal, Que.-City Council. 1 bound vol.
National Board of Fire Underwriters. 2 pam.
National Elec. Light Assoc. 2 bound vol.
National Irrig. Congress. 1 vol.
New Jersey-State Board of Health. 1 bound vol.
New London, Conn.-Board of Water and Sewer Commrs. 1 pam.
New South Wales-Bureau of Statistics. 2 pam.
New York City Record. 3 bound vol.
Newcastle & Gateshead, England, Water Co. 1 pam.
North, Edward P. 1 vol.
Ontario, Canada-Bureau of Mines. 1 vol.
Oxford, England-Water-Works. 7 pam.
Pennsylvania-Health Comm. 1 bound vol.
Philadelphia, Pa.-Dept. of Public Health and Charities. 2 pam.
St. John, N. B.-City Engr. 1 pam.
Smithsonian Institution. 1 bound vol.
Southend, England-Water-Works Co. 3 pam.
Sprague, Frank J. 1 pam.
Stafford, England-Water-Works. 2 pam.
Tokyo Imperial Univ. 1 vol.
Toledo, St. Louis & Western R. R. Co. 1 pam.
Tomkins, Calvin. 1 pam.
Tonindustrie-Zeitung. 1 bound vol., 2 pam.
Torquay, England-Water-Works. 1 pam.
Uhlig-Carl. 1 pam.
Union Coll. 1 vol.
Union Pacific R. R. Co. 2 pam.
Union Univ. 1 pam.
Uruguay-Obras Publicas. 1 bound vol.
U. S.-Bureau of Labor. 1 vol.
U. S.-Bureau of the Census. 1 bound vol.
U. S.-Bureau of Mines. 1 pam.
U. S.-Bureau of Statistics. 4 pam.
U. S.-Commr. of Corporations. 1 vol.
U. S.-Forest Service. 1 pam.
U. S.-Isthmian Canal Comm. 1 vol., 29 maps.
U. S.-National Museum. 2 pam.
U. S.-Navy Dept. 2 pam.
U. S.-Office of Exper. Stations. 1 pam.
U. S.-War Dept. 1 pam.
Wallasey, England-Water-Works. 2 pam.
Washington, Univ. of. 1 vol.
Watson, Wilbur J. 1 pam.
Western Australia-Goldfield Water Supply. 1 pam.
Woodworth, R. B. 1 pam.
Worcester Polytechnic Inst. 1 vol.
Wyoming-State Engr. 4 pam.

BY PURCHASE

The Mineral Industry. Its Statistics, Technology and Trade During 1909. Edited by Walter Renton Ingalls. Vol. 18. McGraw-Hill Book Company, New York, 1910.

Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, insbesondere aus den Laboratorien der technischen Hochschulen, herausgegeben vom Verein deutscher Ingenieure. Hefte 93 und 94. Julius Springer, Berlin, 1910.

The Improvement of Fort Wayne, Indiana. Report of Charles Mulford Robinson, 1910. Fort Wayne Printing, Fort Wayne, Ind.

Principles of Metallurgy. An Introduction to the Metallurgy of the Metals. By Charles Herman Fulton. McGraw-Hill Book Company, New York, 1910.

SUMMARY OF ACCESSIONS.

(From November 8th to December 12th, 1910)

Donations (including 27 duplicates)	242
By Purchase	4
Total	246

MEMBERSHIP

ADDITIONS

(From November 9th to December 13th, 1910)

MEMBERS		Date of Membership.
Armstrong, Alexander Floyd. Chf., Bureau of Research, State Dept. of Highways, Albany, N. Y.	Jun. Assoc. M. M.	Oct. 7, 1902 Nov. 1, 1905 Dec. 6, 1910
Barr, Joseph Carroll. Contr. Engr. (J. C. Barr Co.), Joplin, Mo.	Assoc. M. M.	Jan. 4, 1899 Nov. 1, 1910
Blickle, Herman Renner. 510 House Bldg., Pittsburg, Pa.		Nov. 1, 1910
Brown, Stephen Pearson. Chf. Engr., The Tide Water Bldg. Co. and Thomas B. Bryson, 641 Fourth Ave., Brooklyn, N. Y.	Assoc. M. M.	Oct. 5, 1904 Nov. 1, 1910
Burger, William Henry. Asst. Prof. of Civ. Eng., Coll. of Eng., Northwestern Univ., Box 174, Evanston, Ill.		Nov. 1, 1910
Curtis, Loren Bradley. Hydr. and Civ. Engr., 710 Kittredge Bldg., Denver, Colo.	Assoc. M. M.	July 10, 1907 Nov. 1, 1910
Decrow, David Augustus. Chf. Engr. and Secy., Snow Steam Pump Works, Buffalo, N. Y.		Oct. 4, 1910
Frederickson, John Henry. 310 First National Bank Bldg., Denver, Colo.		Nov. 1, 1910
Fry, Alfred Brooks. Chf. Engr., U. S. Treasury Service, and Member of Board of Cons. Engrs. for Impvt. of New York State Canals, 727 U. S. Custom House Bldg., New York City		Dec. 6, 1910
Hartman, Russell Theodore. Care, Des Moines Bridge & Iron Works, Des Moines, Iowa	Assoc. M. M.	May 4, 1909 Nov. 1, 1910
Holtzman, Stephen Ford. 11 East 24th St., New York City (Res., Hastings-on-Hudson, N. Y.)	Assoc. M. M.	Mar. 7, 1906 Nov. 1, 1910
Jervey, James Postell. Maj., Corps of Engrs., U. S. A.; Res. Engr., Gatun Locks, Gatun, Canal Zone, Panama.		Nov. 1, 1910
Lee, David Read. 12 Lake Ave., Middletown, N. Y.	Assoc. M. M.	Oct. 7, 1896 Nov. 1, 1910
Pfau, Julius Welch. Engr. of Constr., N. Y. C. & H. R. R. R., Room 1101, Grand Central Station, New York City	Assoc. M. M.	Dec. 2, 1903 Dec. 6, 1910
Strahan, Charles Morton. Prof., Civ. Eng., Univ. of Georgia, Athens, Ga.	Assoc. M. M.	June 1, 1898 Nov. 1, 1910
Washburn, Delos Cuyler. Aberdeen, S. Dak.		May 3, 1910

ASSOCIATE MEMBERS		Date of Membership.
ABBOTT, HUNLEY. Care, MacArthur Bros. Co., 11 Pine St., New York City	Jun. Assoc. M.	Sept. 5, 1905 Dec. 6, 1910
ALLEN, CHESTER SALISBURY. Concrete Engr., Lockwood, Greene & Co., 93 Federal St., Boston, Mass	Jun. Assoc. M.	Dec. 4, 1906 Oct. 4, 1910
ALLEN, RAYMOND CLEAVELAND. Lock Box 9, Manchester, Mass		Dec. 6, 1910
AVERILL, JAMES LELAND. Chf. Engr. for Hamilton & Chambers, 206 West 106th St., New York City		Dec. 6, 1910
BARNES, FRANK WILLIAM, JR. 134 Elm St., North Cambridge, Mass		Dec. 6, 1910
BARRETT, ROBERT EDWARD. Asst. Engr. Designer, New York Board of Water Supply, 127 Franklin St., New York City	Jun. Assoc. M.	Jan. 31, 1905 Dec. 6, 1910
BONIFACE, ARTHUR. Asst. Engr., Rapid Transit Subway Constr. Co., 165 Broadway, New York City	Jun. Assoc. M.	Jan. 2, 1906 Oct. 4, 1910
BURT, LUTHER HAROLD. Asst. Engr., Bronx Valley Sewer Comm., 3 Borneman Pl., White Plains, N. Y		Nov. 1, 1910
BUTLER, GEORGE. County Surv., Court House, San Diego, Cal		Sept. 6, 1910
CADLE, CHARLES LONGFORD. 267 State St., Rochester, N. Y.		Nov. 1, 1910
CHAPPELL, CLAUDE EDWARD. City Engr., 247 Britain Ave., Benton Harbor, Mich	Jun. Assoc. M.	Sept. 1, 1908 Sept. 6, 1910
CHASSAING, CHARLES WILLIS. Care, Selden-Breck Constr. Co., Fullerton Bldg., St. Louis, Mo		Sept. 6, 1910
COLLINS, STEWART GARFIELD. Engr., MacLeod & Smith, 705 Sellwood Bldg., Duluth, Minn		Nov. 1, 1910
EGBERT, WARREN. 805 McDonald Ave., Santa Rosa, Cal		Nov. 1, 1910
EITZEN, ARTHUR ROBERT. Care, Kansas City Terminal Ry. Co., 23d and Grand Ave., Kansas City, Mo	Jun. Assoc. M.	Sept. 6, 1904 Nov. 1, 1910
FOSS, JOHN HARRISON. Instr., Civ. Eng. Dept., Leland Stanford, Jr., Univ., P. O. Box 65, Palo Alto, Cal	Jun. Assoc. M.	Dec. 1, 1903 Oct. 4, 1910
GARRIGUES, HENRY HAYDOCK. Supervisor No. 2, Allegheny Div., P. R. R., Kittanning, Pa	Jun. Assoc. M.	Oct. 31, 1905 June 30, 1910
GRAY, HARRY WOY. Asst. Prof. of Experimental Civ. Eng., Iowa State Coll., Ames, Iowa		Nov. 1, 1910
HANAVAN, WILLIAM LAWRENCE. Asst. Engr., Board of Water Supply of New York City, R. F. D. No. 4, Newburgh, N. Y	Jun. Assoc. M.	Dec. 6, 1904 Dec. 6, 1910
HANLEY, WILLIAM SCOTT. 252 West 65th St., Chicago, Ill		Nov. 1, 1910
HAYS, DONALD SYMINGTON. Box 1586, Victoria, B. C., Canada		Oct 4, 1910

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
McLoughlin, Joseph Navarre. Asst. Supt., Ore. Short Line R. R. Co., Box 198, Pocatello, Idaho		Nov. 1, 1910
Martin, Richard Herbert. Prin. Asst. Engr., Florida East Coast Ry., P. O. Box 143, St. Augustine, Fla		Oct. 4, 1910
Mitchell, Louis Adolph. 212 Barclay St., Flushing, N. Y.		May 31, 1910
Morrison, George Eldridge. City Engr., 1015 Douglas Ave., East Las Vegas, N. Mex		Nov. 1, 1910
Neely, John Thompson. Engr., McClintic-Marshall Constr. Co., Box 238, Rowlesburg, W. Va		Dec. 6, 1910
Rice, John Marie Thomas. Div. Engr., Bureau of Filtration, Dept. of Public Works (Res., 5307 Butler St.), Pittsburg, Pa	Jun. Assoc. M.	April 2, 1907 Dec. 6, 1910
Shaw, William Thomas. Asst. Engr., Boston Elev. Ry. Co., 1822 Beacon St., Brookline, Mass		June 30, 1910
Spelman, John Rodgers. Cons. Engr., 125 East 23d St., New York City		Dec. 6, 1910
Stabler, Herman. Care, U. S. Geological Survey, Washington, D. C		Nov. 1, 1910
Tompkins, Charles Hook. (I. F. Fisher, Engrs. and Contrs.), 149 Rhode Island Ave., N. W., Washington, D. C		Dec. 6, 1910
Wade, George Willis. Asst. Engr., S. P. Co., 3d and Townsend Sts., San Francisco, Cal		Nov. 1, 1910

ASSOCIATE

Christian, Charles Meriwether. 24 News Press Bldg., Poughkeepsie, N. Y	Nov. 1, 1910

JUNIORS

Backus, Murray James. Asst. Engr., Guanica Centrale, Ensenada, Porto Rico	Oct. 4, 1910
Beebe, John Cleaveland. 44 Montana National Bank Bldg., Helena, Mont	Nov. 1, 1910
Davenport, Royal William. Prineville, Ore	Oct. 4, 1910
Dodds, David Metheny. Box 65, Swink, Colo	Nov. 1, 1910
Garvey, Victor Hugo. Asst. Engr., Stone & Webster, Sumner, Wash	Nov. 1, 1910
Henderson, John Taylor. Acting Mgr., Big Lost River Irrig. Co., Arco, Idaho	Nov. 1, 1910
Hutchins, Roland Ellis. 315 Brown St., Iowa City, Iowa	Nov. 1, 1910
Lynch, Alexander Sydney. U. S. Junior Engr., 57 Holmes St., West Haven, Conn	Dec. 6, 1910
Rome, Lyford. 334 Schermerhorn St., Brooklyn, N. Y.	Nov. 1, 1910

JUNIORS (*Continued*)

	Date of Membership.
SEARIGHT, GEORGE PETER. 30 South Bleeker St., Mount Vernon, N. Y.	Nov. 1, 1910
SWETT, WILLIAM CLAUDE. Asst. Engr., Ore. Short Line R. R., P. O. Box 51, Pocatello, Idaho	Nov. 1, 1910
TORRALBAS, RAFAEL JOAQUIN. With Cuban Eng. & Contr. Co., 640 J del Monte, Havana, Cuba	Nov. 1, 1910
WETHERELL, DWIGHT NELSON. 115 North Garrison Ave., Carthage, Mo	Nov. 1, 1910

DEATHS

CHANUTE, OCTAVE (*Past-President*). Elected Member, February 19th, 1868; Fellow, July 11th, 1872; died November 23d, 1910.

MACFARLANE, ARTHUR KEDDIE. Elected Junior, October 5th, 1909; died November 1st, 1910.

MYERS, GEORGE HIGGINS. Elected Junior, June 1st, 1909; died October 10th, 1910.

WILKINS, GEORGE SHREVE. Elected Junior, October 4th, 1892; Associate Member, October 5th, 1898; died August 7th, 1910.

Total Membership of the Society, December 13th, 1910,

5 779.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(November 8th to December 12th, 1910)

NOTE.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal,* Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings,* Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions,* Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly,* Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator,* Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine,* New York City, 25c.
(10) *Cassier's Magazine,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News,* New York City, 15c.
(14) *The Engineering Record,* New York City, 12c.
(15) *Railway Age Gazette,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway and Engineering Review,* Chicago, Ill., 10c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 10c.
(21) *Railway Engineer,* London, England, 25c.
(22) *Iron and Coal Trades Review,* London, England, 25c.
(23) *Bulletin,* American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal,* New York City, 10c.
(25) *American Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique,* Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France.
(34) *Portefeuille Economiques des Machines,* Paris, France.
(35) *Nouvelles Annales de la Construction,* Paris, France.
(37) *Revue de Mécanique,* Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways,* Paris, France.
(41) *Modern Machinery,* Chicago, Ill., 10c.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Pontes et Chaussées,* Paris, France.
(44) *Journal,* Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals,* Scranton, Pa., 20c.
(46) *Scientific American,* New York City, 8c.
(47) *Mechanical Engineer,* Manchester, England.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(51) *Deutsche Bauzeitung,* Berlin, Germany.
(52) *Rigasche Industrie-Zeitung,* Riga, Russia.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions,* Am. Soc. C. E., New York City, $4.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $5.

(57) *Colliery Guardian,* London, England.
(58) *Proceedings,* Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.
(59) *Transactions,* Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.
(60) *Municipal Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *Industrial World,* 59 Ninth St., Pittsburg, Pa.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 20c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Journal of Gas Lighting,* London, England, 15c.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(68) *Mining Journal,* London, England.
(70) *Engineering Review,* New York City, 10c.
(71) *Journal,* Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.
(73) *Electrician,* London, England, 18c.
(74) *Transactions,* Inst. of Min. and Metal., London, England.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
(76) *Brick,* Chicago, Ill., 10c.
(77) *Journal,* Inst. Elec. Engrs., London, England.
(78) *Beton und Eisen,* Vienna, Austria.
(79) *Forscherarbeiten,* Vienna, Austria.
(80) *Tonindustrie Zeitung,* Berlin, Germany.
(81) *Zeitschrift für Architektur und Ingenieurwesen,* Wiesbaden, Germany.
(83) *Progressive Age,* New York City, 15c.
(84) *Le Ciment,* Paris, France.
(85) *Proceedings,* Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.
(86) *Engineering-Contracting,* Chicago, Ill., 10c.
(87) *Roadmaster and Foreman,* Chicago, Ill., 10c.
(88) *Bulletin* of the International Ry. Congress Assoc., Brussels, Belgium.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa.
(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(94) *The Boiler Maker,* New York City, 10c.
(95) *International Marine Engineering,* New York City, 20c.
(96) *Canadian Engineer,* Toronto, Ont., Canada, 15c.
(97) *Turbine,* Berlin, Germany, 1 Mark.
(98) *Journal,* Engrs'. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $1.50.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., $1.
(101) *Metal Worker,* New York City, 10c.
(102) *Organ für die Fortschritte des Eisenbahnwesens,* Wiesbaden, Germany.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, Eng., 6d.
(105) *Metallurgical and Chemical Engineering,* New York City, 25c.

LIST OF ARTICLES.

Bridges.

The Highest Bridges in the World. (13) Nov. 10.
Converting a Steel Trestle into a Reinforced Concrete Trestle. (13) Nov. 10.
The Removal of the Debris of the Old Quebec Bridge.* H. P. Borden, Assoc. M. Can. Soc. C. E. (13) Nov. 10.
The Walpole Bridge.* (14) Nov. 12.
The Beaver Bridge Piers.* (14) Nov. 19.
Tests of Nickel-Steel Models of Compression Members in the Official Design of the New Quebec Bridge.* (14) Nov. 19.
Construction of the Kinzie St. Drawbridge (Chicago) and its Deep Foundations: Chicago & Northwestern Ry.* W. H. Finley, M. Am. Soc. C. E. (13) Nov. 24.
The Meadow St. Reinforced-Concrete Arch Bridge, Pittsburg, Pa.* N. S. Sprague, M. Am. Soc. C. E. (13) Dec. 1.
Construction and Reconstruction of the Coteau Bridge.* (14) Dec. 3.
The St. Louis Municipal Bridge Superstructure.* (14) Dec. 3.
Viaduc sur la Sitter, à Kubel, près de Saint-Gall (Suisse).* (33) Nov. 26.
Strassenbahn-Viaduct bei Horst-Emscher.* Färber. (51) Serial beginning Sup. 21.
Uber den Bau der Donaubrücke für das Zweite Gleis der Nordwestbahn in Wien.* Josef Walter. (53) Serial beginning Nov. 11.
Die Kaiserbrücke über die Oder in Breslau.* (51) Nov. 12.

---

*Illustrated.

Electrical.

Interconnected Massachusetts Generating Plants; System and Operating Features of the Greenfield Electric Light & Power Company.* (27) Nov. 3.
Electric Power Supply on the Northeast Coast.* (22) Serial beginning Nov. 4.
On Magnetic Alloys Formed from Non-Magnetic Materials. Alexander D. Ross. (Paper read before the Inst. of Metals.) (11) Nov. 4.
Protection of Gas and Water Mains from Destruction by Electric Currents.* (66) Nov. 8.
Power-Factor and Rotary Condensers.* L. S. Thurston. (27) Nov. 10.
Electrostatic Limits in High-Tension Transmission-Line Insulators.* (27) Nov. 10.
Reconstruction Work in Salt Lake City; Improvements and Additions to the System of the Utah Light & Railway Company, of Salt Lake City.* (27) Nov. 10.
The Energy Relations of Certain Detectors used in Wireless Telegraphy.* W. H. Eccles. (Abstract of paper read before the Physical Soc.) (26) Nov. 11.
Some Observations on the Action of the Condenser in a Ruhmkorff Induction Coil.* J. W. Waghorn. (73) Nov. 11.
By Cable to the Arctic. George E. Walsh. (19) Nov. 12.
Effects of the Form of Electromotive Force Waves upon the Life and Efficiency of Incandescent Lamps.* (27) Nov. 17.
Data on an Electrical Resistance Furnace.* Albert A. Somerville. (27) Nov. 17.
Hydro-Electric Commission, Test on Insulators. (96) Nov. 17.
A Remarkable Vector Diagram.* Henry Tinsley. (73) Nov. 18.
New Reading Central Station.* (14) Nov. 19.
Is a Rational Basis Possible for Telephone Rates? Dugald C. Jackson. (Paper read before the National Municipal League.) (96) Nov. 24.
Street-Lighting Costs.* C. Toone. (26) Nov. 25.
A Chemical Specification for Rubber-Covered Wires and Cables. C. R. Boggs. (27) Nov. 27.
The Electrical Conductivity of Commercial Copper. F. A. Wolff and J. H. Dellinger. (Abstract from *Bul.* Bureau of Standards.) (42) Dec.
The Municipal Lighting Plant at Bellefontaine, Ohio.* (60) Dec.
Some Alloys for Permanent Magnets. C. F. Burgess and James Aston. (105) Dec.
Mechanical Forces in Magnetic Fields. Charles P. Steinmetz. (42) Dec.
The New Era in Electrical Illumination.* Rollin W. Hutchinson, Jr. (9) Dec.
Problems in the Operation of Transformers.* F. C. Green. (42) Dec.
Estimated Cost of an Industrial Electric Plant. (27) Dec. 1.
Some Notes on Ground Connections.* Edgar H. Holmes. (27) Dec. 1.
Surges in Pipe Lines.* F. G. Baum. (27) Dec. 8.
Creosote Treatment for Poles. George R. Ogier. (Paper read before the Colo. Elec. Light, Power and Ry. Assoc.) (96) Dec. 8.

Marine.

The Propulsion of Ships. John Batey. (10) Nov.
The North Sea Fisheries and Fishing Exhibition. (12) Serial beginning Nov. 4.
The French Liner *France.** (95) Dec.
Metallic Life-Boats.* (95) Dec.
Launch of the *Olympic.** (95) Dec.
New Southern Pacific Freight Steamships.* (95) Dec.
The Economical Working of Reciprocating Marine Engines and their Auxiliaries.* D. B. Morison. (Abstract of paper read before the North-East Coast Inst. of Engrs. and Shipbuilders.) (47) Dec. 2; (11) Serial beginning Dec. 2.
Les Ecluses du Kruisschans. C. J. Van Mierlo. (31) Vol. 3, Pt. 3.

Mechanical.

Expansion of Pipes.* Ralph C. Taggart, Assoc. M. Am. Soc. C. E. (54) Vol. 70.
The Semet-Solvay By-Product Coke Oven.* W. W. Davis. (98) Oct.
Baltimore Retort & Fire Brick Co.* H. A. Phillips. (76) Nov.
Boiler Tube Soot Cleaners.* Warren O. Rogers. (64) Nov.
The Borsig Locomotive Shops.* (From *American Machinist.*) (94) Nov.
Central Station at Newcastle, Indiana.* Osborn Monnett. (64) Nov.
Cost of Trenching with a Power Operated Scraper Excavator.* (87) Nov.
English Navies and American Steam Shovels.* A. F. Dickinson. (10) Nov.
Low Pressure Steam Turbines.* F. E. McKee. (58) Nov.
Machine Tools at the Brussels Exposition.* J. O. Newman. (10) Nov.
Manganese Steel. J. E. Johnson, M. Utah Soc. of Engrs. (Paper read before the Utah Soc. of Engrs.) (1) Nov.
Manufacture and Use of Slag Cement and Other Substitutes for Portland Cement. W. D'Rohan. (67) Nov.
Fuel Requirements of the Rotary Kiln. (67) Nov.
Oxy-Acetylene Welding.* J. F. Springer. (94) Nov.
The Steam Turbine in Germany.* J. E. Junge and E. Heinrich. (64) Nov.
Success of System in Brickmaking.* (76) Nov.

---

*Illustrated.

Mechanical – (Continued).

Large Gas Engines and their Troubles.* Frank Foster. (Paper read before the Manchester Exhibition.) (47) Nov. 4.

The "Managing" of Winding and Rolling Mill Engines.* (From a paper read before the Düsseldorf Congress.) H. Hoffman. (22) Nov. 4.

The Manufacture of Portland Cement. A. C. Davis, Assoc. Inst. C. E. (Abstract of paper read before the Concrete Inst.) (104) Nov. 4.

The Olympia Motor Exhibition.* (11) Serial beginning Nov. 11; (12) Serial beginning Nov. 4.

Comparison of Lubricating Greases.* Horace W. Gillett. (64) Nov. 8.

The Phenomena of Explosions in Gas and Other Internal Combustion Engines.* Dugald Clerk. (Paper read at the Manchester University.) (66) Nov. 8.

A Wooden-Apron Conveyor Carrying Miscellaneous Freight from Wharf to Warehouse.* (13) Nov. 10.

Strainer for Condenser Circulating Water at Deptford.* (11) Nov. 11.

Torque and Balancing of Internal-Combustion Engines.* A. J. T. Kersey. (Paper read at Manchester, Oct. 31st, 1910.) (47) Nov. 11.

Pneumatic Calking of Mains with Lead Wool. Colin C. Simpson, Jr. (Abstract of a paper read before the Amer. Gas Inst.) (14) Nov. 12; (86) Dec. 7.

Ammonia Recovery, with Special Reference to the Apparatus Employed Therein.* W. H. Johns. (Paper read before the Midland Junior Gas Engr. Assoc.) (66) Nov. 15.

Experiments with Tile Roof Furnaces.* A. Bement. (64) Nov. 15.

The Problem of Smoke Abatement. D. T. Randall. (64) Nov. 15.

Recent Progress in, and the Present Status of, Gas Lighting.* F. W. Goodenough. (Abstract of paper read before the Illuminating Eng. Soc.) (66) Nov. 15.

Under-Feed Automatic Stokers.* J. F. Springer. (64) Nov. 15.

Unusual Applications of Cutting and Welding Torches.* (41) Nov. 15.

Gas Producer Design and Operation.* P. Von Zeipel. (20) Nov. 17.

Smoke Prevention.* H. M. Nicholls. (20) Nov. 17.

New Power Generating and Distributing System in Reading, Pa.* (17) Nov. 19; (27) Nov. 17; (64) Nov. 22.

The Brittleness of Steel in its Relation to Boilers.* C. E. Stromeyer. (Abstract from report of the Manchester Steam Users' Assoc.) (22) Nov. 18.

Electric Equipment of King Edward Building.* (73) Nov. 18.

Humphrey Pumps and Compressors.* Herbert A. Humphrey, M. Inst. C. E. (Paper read before the Manchester Assoc. of Engrs.) (11) Nov. 18; (12) Nov. 18; (47) Nov. 18.

A New Power Scheme for the General Post-Office.* (12) Serial beginning Nov. 18; (73) Serial beginning Nov. 18; (26) Serial beginning Nov. 18.

The Laurin & Leitch Rock-Crushing Plant.* Paul C. Van Zandt. (14) Nov. 19; (96) Dec. 1.

The Largest Valves in the World.* (64) Nov. 22.

Motor Trucks and Delivery Wagons.* H. W. Perry. (20) Nov. 24.

Norwegian Electric Furnaces.* (20) Nov. 24.

Heat Accumulators for Utilising Exhaust Steam.* E. Stach. (Paper read before Düsseldorf Congress.) (22) Nov. 25.

The Proportions of Rolling-Stock Journals. T. Robson, A. M. Inst. C. E. (11) Nov. 25.

Aerial Ropeway at Steetley Quarries.* (11) Nov. 25.

The "Sentinel" Air-Compressors.* (57) Nov. 25.

Modern Rotary Steam Engines.* Warren O. Rogers. (19) Nov. 26.

Waste Heat Utilization in Water Gas Apparatus. J. Hawley Taussig. (Paper read before the Amer. Gas Inst.) (24) Nov. 28; (83) Dec. 1.

Charging a Refrigerating System. F. E. Matthews. (64) Nov. 29.

The Economy of Smoke Prevention.* J. A. Switzer. (9) Dec.

The Generation of Power. D. S. Jacobus. (3) Dec.

Falcone Oven Tile-Laying Machine.* (45) Dec.

Retort Coke Ovens in Mexico.* E. B. Wilson. (45) Dec.

Test of a Babcock & Wilcox Marine Boiler. (95) Dec.

Testing Steam Turbines and Steam Turbo-Generators. E. D. Dickinson and L. T. Robinson. (42) Dec.

The Gyroscope and its Useful Possibilities.* Elmer A. Sperry. (20) Serial beginning Dec. 1.

Relations Between Pressure and Light Output With Various Gas Lamps and Burners. Norman Macbeth. (Paper read before the Illuminating Eng. Soc.) (83) Dec. 1.

Station of the Empire District Electric Company.* M. R. Bump. (27) Dec. 1.

Water Power and Combination Steam Plants at Jonesville, Wis.* (27) Dec. 1.

Steam-Boiler Design. Charles Erith, A. M. I. Mech. E. (11) Dec. 2.

Experiments on a Bomb Calorimeter. E. A. Allcut. (11) Dec. 2.

The Sheppee Convertible Steam Motor-Vehicle.* (11) Dec. 2.

Involute Cut Gearing.* S. H. Rowley, M. I. M. E. (Paper read before the Manchester Assoc. of Engrs.) (47) Serial beginning Dec. 2.

The New Crescent Portland Cement Mill.* (14) Dec. 3.

---

*Illustrated.

Mechanical—(Continued).

The Wetterhorn Lift at Grindelwald, Switzerland.* E. L. Corthell. (14) Dec. 3.
Laying Large Submerged Gas Mains at New York.* Colin C. Simpson. (Abstract of paper read before the Amer. Gas Inst.) (14) Dec. 3.
The Extraction of Cyanogen from Coal Gas at the Astoria Works.* M. E. Mueller. (Paper read before the Amer. Gas Inst.) (24) Dec. 5.
Soot Blowers and Soot Suckers.* Warren O. Rogers. (64) Dec. 6.
A Comparison of the Cost of Operating Different Classes of Buildings with Central Station and Isolated Plant Service. C. M. Ripley. (Abstract of paper read before the Blue Room Eng. Soc. of Greater New York.) (86) Dec. 7.
Swedish Generating Station, the Extension of the Municipal Steam Electric Power Station of Stockholm.* E. Andreason. (27) Dec. 8.
Iron Ore and Flue Dust Briquetting.* (20) Dec. 8.
A Rock-Transporting Cableway for the Harbor Works of Rangoon, Burmah.* (13) Dec. 8.
Analysis of Velocity Ratios of Epicyclic Gear Trains.* A. Lewis Jenkins. (13) Dec. 8.
The Briquetting of Coal Dust.* Lindon Bates. (19) Dec. 10.
An English Automobile Turbine Fire Pump.* Frank C. Perkins. (46) Dec. 10.
A Process for Saving Wastes in Smeltery Gases. George C. Westby. (16) Dec. 10.
Determination of the Calorific Value and of Operating Conditions from Analysis of Industrial Gases.* J. M. Morehead. (Paper read before the Amer. Gas Inst.) (24) Dec. 12.
Calcul de la Résistance de Rupture des Ailes d'Hélices Propulsives.* E. Prayon. (31) Vol. 3, Pt. 3.
La Construction des Automobiles.* G. Van Engelen. (31) Vol. 3, Pt. 3.
Note sur le Pont Levant Hydraulique de Wattrelos.* Wibrattre. (43) Sept.
La IIe Exposition de Locomotion Aérienne.* G. Espitallier. (33) Oct. 29.
Considérations sur les Phénomènes Physiques Existant dans les Pompes Centrifuges.* L. Bergeron. (37) Oct. 31.
Binard Automobile, Système Schneider, pour le Transport des Pierres de Taille.* (33) Nov. 19.
Uber den Wasserschlag.* Rudolf Escher. (97) Oct. 5.
Ueber neuere Lauftrommeln für Dampfturbinen.* W. Gentsch. (97) Oct. 20.
Die Turbinen der Wasserkraftanlage in Grand Falls, Neufundland, erbaut von Amme, Giesecke & Konegen, A.-G. Braunschweig.* V. Gelpke. (48) Oct. 29.
Die Dampfturbine von Curtis, ihre Vorläufer und Nachfolger.* Wens. (97) Nov. 5.
Die Gleichstrom-Dampfmaschine.* J. Stumpf. (48) Serial beginning Nov. 5.
Seilschwebebahnen für Personenbeförderung.* M. Buhle. (51) Serial beginning Nov. 5.
Neue Giesserei-Anlage der Hartung Akt.-Ges. in Berlin-Lichtenberg.* Th. Ehrhardt. (50) Nov. 9.
Elektromagnetische Eisenseparatoren im Giessereibetriebe.* Erich Oppen. (50) Nov. 9.
Ueber die Herstellung von T-Eisen und breitflanschigen Trägern mit neigungslosen Flanschen.* (50) Nov. 16.
Versuche mit Dampfentölern.* (48) Serial beginning Nov. 19.
Schwenkdüsen, ihre Konstruktion und ihre Aufgaben.* Kröner. (97) Nov. 20.
Wann wird ein Regulator schwankungslos Arbeiten?* Albert Hoeppener. (97) Serial beginning Nov. 20.
Die Fabrikation der Weisbleche.* W. Krämer. (50) Serial beginning Nov. 23.
Kalk- und Zementherstellung in Süd-Frankreich.* Fiebelkorn. (80) Nov. 26.

Metallurgical.

Iron and Steel Analysis; an Important Error in Sulphur Tests. George Auchy. (20) Nov.
Are the Reactions in the Blast Furnace Known? Alex. D. Elbers. (62) Nov. 7.
Shrinkage of Alloys during Solidification.* Donald Ewen and T. Turner. (Paper read before the Inst. of Metals.) (11) Nov. 11.
Electrolytic Determination of Lead in Ores. R. C. Benner and W. H. Ross. (103) Nov. 12.
The Outlook for Hydrometallurgy of Copper. William E. Greenawalt. (16) Nov. 12.
The New Blast Furnace of the Detroit Iron and Steel Company.* (20) Nov. 17.
The Greenawalt Electrolytic Process.* William E. Greenawalt. (16) Nov. 26.
Some Calculations Pertaining to the Reactions Occurring in a Blast Furnace. W. D. Brown. (105) Dec.
Notes on the Chemistry and Metallurgy of Vanadium. Warren F. Bleecker. (105) Serial beginning Dec.
An Australian Electrolytic Copper Refinery.* R. G. Casey, Jr. (16) Dec. 3.
First Norwegian Electric Steel Works.* Alfred Gradenwitz. (19) Dec. 10.
Mémoire, le Congrès International de la Métallurgie à Düsseldorf.* Arnou. (93) Nov.

---

*Illustrated.

Metallurgical—(Continued).

Fortschritte auf dem Gebiete der Hochofenbegichtung.* H. Aumund. (50) Serial beginning Nov. 2.
Untersuchungen über die Stof- und Wärmebilanz des Hochofens. W. G. Gillhausen. (50) Nov. 16.

Military.

Guns for Attacking Airships.* (19) Nov. 12.
The Gabet Torpedo. Controlling a Torpedo by Wireless Energy. Lucien Fournier. (19) Nov. 26.
Silencer for Military Rifles. J. P. Farley. (19) Dec. 3.

Mining.

Federal Investigations of Mine Accidents, Structural Materials, and Fuels.* Herbert M. Wilson, M. Am. Soc. C. E. (54) Vol. 70.
The Caledonia Cut-Off Gear for Winding Engines.* (57) Nov. 4.
Coal Washing v. Picking.* (22) Nov. 4.
Methods of Dealing with Fires, Explosions and Falls in Mines.* Alfred J. Tonge. (Paper read before the Manchester Geol. and Min. Soc.) (22) Nov. 11.
A Concrete Shaft at Tower, Minnesota.* P. F. Chamberlain. (14) Nov. 12.
Dry-Placer Machines. Glenn M. Peterson. (103) Nov. 12.
Some of the Characteristics of Chilean Mills.* Herbert A. Megrau. (16) Nov. 12.
Electric Hoisting in Mining Operations.* S. F. Walker. (16) Nov. 19.
American Longwall Mining Methods.* Henry M. Payne. (16) Nov. 19.
Methods of Detecting Fire-Damp in Mines. Sir Henry H. Cunynghame. (29) Nov. 25.
A Revolution in Mining Methods. G. E. Wolcott. (103) Nov. 26.
The Use of Coal Cutting Machinery.* R. H. Rowland. (16) Nov. 26.
Chemistry of Coal-Dust Explosions.* (45) Dec.
The Taylor Concrete Breaker.* E. B. W. (45) Dec.
Hydrometallurgy of Cobalt Ores.* E. B. W. (45) Dec.
Tin Sluicing in Tasmania.* Edward Edwards. (Abstract from *Bulletin* of Australasian Inst. of Min. Engrs.) (45) Dec.
The Buddle as a Concentrator of Copper Slimes.* Claude T. Rice. (16) Dec. 3.
A Large Concrete Coal Breaker and Washery Building.* (14) Dec. 3.
Extension of a Colliery Working Shaft.* M. S. Hachita. (16) Dec. 10.
Der Ersatz des Handarbeiters durch die Maschine im Bergbau.* Kammerer. (48) Serial beginning Nov. 5.
Zur neuen Schiessinstruktion der Steinbruchs-Berufsgenossenschaft. (80) Serial beginning Nov. 12.

Miscellaneous.

Address at the 42d Annual Convention, Chicago, Ill., June 21st, 1910. John A. Bensel, President, Am. Soc. C. E. (54) Vol. 70.
Pressure, Resistance, and Stability of Earth.* J. C. Meem, M. Am. Soc. C. E. (54) Vol. 70.
Forestry and Columbia. C. C. Curtis. (6) July.
Utilising the Energy of Solar Radiation, the Wind and Other Intermittent Natural Sources. R. A. Fessenden. (Paper read before the Brit. Assoc.) (47) Nov. 4.
Producers' Oil Pipe Lines, California. A. T. Parsons. (14) Nov. 12.
The Conservation Movement. C. W. Hayes. (103) Nov. 19.
Wisconsin Rulings on the Reasonableness of Rates. (14) Nov. 19.
Elements of a Constructive Franchise Policy. Delos F. Wilcox. (Abstract of paper read before the Nat. Municipal League.) (13) Dec. 8.
Graphical Solution of Problems Involving Plane-Surface Lighting Sources.* A. S. McAllister. (27) Dec. 8.

Municipal.

Tarred Roads and the Eyes. (104) Nov. 4.
Tests of Various Road Surfacing Materials by the Ohio State Highway Department. (13) Nov. 10.
Toronto's Experiments With Crude Oil. Chas. Sheard. (96) Nov. 10.
Arrangement of Mixer with Chutes for Concreting Street Railway Tracks.* (86) Nov. 16.
Comparative Costs of Macadam, Rocmac and Tarviated Roads. G. Bertram Hartfree. (Abstract of paper read before the Inst. of Mun. and County Engrs.) (86) Nov. 16.
The Location of Light Railways in Roads. M. Galliot. (Abstract of paper read before the Inter. Road Cong.) (14) Nov. 19.
Free Carbon in Tar. Joseph Race. (104) Nov. 25.
Surface Treatment for Dust Laying. (104) Nov. 25.
Top Soil Roads in Clarke County, Georgia. C. M. Strahan.* (60) Dec.
Experimental Bituminous-Macadam Pavements on the White Plains Road, Bronx Borough, New York City. (86) Dec. 7.

---

*Illustrated.

Municipal – (Continued).

Methods of Constructing Tar Macadam at Prahran, Australia. W. Calder. (Abstract of paper read before the Melbourne Univ. Eng. Soc.) (86) Dec. 7.
Two Years' Experience in Dust Suppression on New Jersey Roads. James Owen. (Abstract of paper read before the State San. Assoc. of N. J.) (14) Dec. 10.
City Design and Transportation. (14) Dec. 19.

Railroads.

Final Report of Special Committee on Rail Sections. (54) Vol. 70.
Locomotive Performance on Grades of Various Lengths.* Beverly S. Randolph, M. Am. Soc. C. E. (54) Vol. 70.
The Hudson River Tunnels of the Hudson and Manhattan R. R. Co. Charles Mattathias Jacobs, M. Inst. C. E. (63) Vol. 81.
Economics of a Locomotive Coaling Stage.* (21) Nov.
Flamme-Rongy Power Reversing Gear; Belgian State Rys.* (21) Nov.
Electrification of Steam Railways in America.* (21) Nov.
Protection of Metal Equipment. William Marshall. (65) Nov.
Standard Locomotives; Saxony State Railways.* (21) Nov.
Locomotive with Water-Tube Fire-Box, Chemin de Fer du Nord.* (12) Nov. 4.
Driving Spiral Tunnels on the Canadian Pacific Ry.* (13) Nov. 10.
Laying and Repairing Cast-Iron Pipe Culverts in Railway Embankments. (Report of Comm. to the Amer. Ry. Bridge and Bldg. Assoc.) (13) Nov. 10.
Car Maintenance Practice at Waltham, Mass.* (17) Nov. 12.
A New Electric Locomotive.* Percy Collins. (46) Nov. 12.
The First Trackless Trolley in America.* (46) Nov. 12.
Forest Fires and Railways.* R. H. Campbell. (96) Nov. 17.
Gravity Freight Classification Yard for the Pennsylvania R. R. at Northumberland, Pa.* W. A. MacCart. (13) Nov. 17.
The Idaho & Washington Northern.* (15) Nov. 18; (18) Nov. 26.
Test of Jacobs-Shupert Firebox.* (15) Nov. 18.
Tests For Color Vision in New South Wales.* S. H. Taylor. (15) Nov. 18.
Boston Electrification Problem.* (17) Nov. 19.
Shops of the National Transcontinental Railway near Winnipeg, Man.* (18) Nov. 19.
Automatic Block Signals on the Illinois Traction System.* (17) Nov. 26.
Mallet Compound Locomotives for the Frisco System.* (18) Nov. 26.
Railway Electrification in Great Britain. (18) Nov. 26.
New Electric Locomotives for the Baltimore & Ohio Railroad.* (17) Nov. 26.
An Excellent Locomotive Terminal.* (25) Dec.
Water Tube Fire Boxes for Locomotives.* (25) Dec.
The Lentz Poppet Valve Gear.* (25) Dec.
High Speeds and Their Relation to Modern Practice in Railway Alignment.* Charles F. Draper. (10) Dec.
The Electrification of the Detroit River Tunnel.* James Cooke Mills. (10) Dec.
The Air-Brake as Related to Progress in Locomotion. Walter V. Turner. (3) Dec.
Descubes System of Signalling, Chemins de Fer de l'Est,* France.* (21) Dec.
Economy of Continuous Brakes on Goods Trains of Feeder Railways on Steep Gradients. W. Glanz. (Abstract of paper read before the Soc. of Ry. Management.) (21) Dec.
Coming Locomotives.* (21) Dec.
Mallet Locomotives for the Chesapeake & Ohio Railway.* (25) Dec.
Heavy Power for the Hocking Valley Ry.* (25) Dec.
The Clark Quick-Dumping Steel Ore Car.* James S. Martin. (13) Dec. 1.
The Economical Maintenance of Tracks and Roadways.* Martin Schreiber. (Paper read before the Amer. Street and Interurban Ry. Eng. Assoc.) (96) Dec. 1.
The Western Pacific Ry.* (13) Dec. 1.
Drop Pit for Engine House.* (15) Dec. 2.
Friction of Freight Car Trucks on Curves.* (15) Dec. 2.
Recording Movements of Switch Points.* (15) Dec. 2.
Tests of Rail Joints.* M'Leod Thompson. (15) Dec. 2.
Opening of the Detroit River Tunnel of the Michigan Central R. R.* (18) Dec. 3.
Some Points Relating to Railway Shop Power Plants.* (18) Dec. 3.
Track Department Standards of New York State Railways. (17) Dec. 3.
The Substitution of Electric Traction for Steam in the Boston Metropolitan District.* (13) Dec. 8.
The Plates on American Railways.* (15) Dec. 9.
The Intercepting Valve and its Operation.* (18) Dec. 10.
Tests of the Edison-Beach Storage Battery Car, Erie R. R.* (18) Dec. 10.
Deflection Recorder for Switch Points, N. Y. O. & W. Ry.* (18) Dec. 10.
Ten-Wheeled Locomotive for the Central Railroad of New Jersey.* (18) Dec. 10.
Note sur l'Organisation de la Manutention Mécanique des Combustibles dans les Principaux Dépots du Reseau d'Orléans.* Lacoin. (38) Nov.

---

*Illustrated.

Railroads—(Continued).

Services de Banlieue du Great Western Railway et la Suppression des Manœuvres de Passage des Locomotives de Tête en Queue en Gare de Paris-Nord.* Emile Bernheim. (38) Nov.
Kugelachslager für Eisenbahnfahrzeuge.* A. Baum. (102) Serial beginning Nov. 1.
Versuchsfahrten mit den neuen Lokomotivgattungen der italienischen Staatsbahnen. Boshart. (102) Nov. 1.
Die bleibenden Formänderungen an den Schienenenden. Weikard. (102) Nov. 1.
Eine neue Betondurchlasskonstruktion.* Frank C. Perkins. (78) Nov. 15.
Die D-Güterzuglokomotive mit 200 qm. Heizfläche (Gattung G 9) der preussisch-hessischen Staatseisenbahnen.* G. Hammer. (48) Nov. 26.

Railroads, Street.

The Cleaning of Tramway Rails. A. Schörling. (Abstract of report to the Union Inter. de Tramways et de Ch. d. Fer d'Intéret Locale.) (73) Nov. 4.
Electric Locomotive for Freight and Switching Service.* (15) Nov. 11.
The Duntley-Rockford Motor Section Car.* (15) Nov. 11.
Ogden Rapid Transit Company.* (17) Nov. 12.
The Basis of Valuation in Case of Municipal Purchase of Street Railways. Sidney Ossoski. (17) Nov. 12.
The Tri-Borough Rapid Transit Subway of New York City.* (86) Nov. 16.
Feeder Calculations for the Chicago Street Railways.* (17) Nov. 19.
Some Notes on Methods and Costs of Chemically Treating Cross Ties (Chicago Street Rys.).* (86) Nov. 23.
Repair Shop Practice of the Portland Railroad Company.* (17) Nov. 26.
Double-Truck Storage Battery Car.* (17) Nov. 26.
Excavation Methods, Fourth Avenue Subway, Brooklyn.* (14) Dec. 3.
Recent Developments in Car Heating and Ventilation. H. S. Williams. (Abstract of paper read before the Central Elec. Ry. Assoc.) (17) Dec. 3.
Valuation of the Chicago Consolidated Traction Property. (17) Dec. 3.
Les Installations Electriques du Chemin de Fer Métropolitain de Paris; Production et Transmission du Courant.* J. Quinat. (33) Serial beginning Nov. 5.

Sanitation.

Expansion of Pipes.* Ralph C. Taggart, Assoc. M. Am. Soc. C. E. (54) Vol. 70.
Birmingham Sewage-Disposal Works. John Duncan Watson, M. Inst. C. E. (63) Vol. 81.
Salisbury Drainage. William Eames Binnie, M. Inst. C. E. (63) Vol. 81.
Sanitary Sewerage System and Sewage Disposal Plant, State Hospital for the Insane, Danville, Pa.* Charles F. Mebus. (98) Nov.
Sewage Purification; its Theory and Present Day Practice. Earle B. Phelps. (98) Nov.
Garbage Disposal Methods Adopted in Some of the Large European Cities. (96) Nov. 10.
The Heating System of the Boston Safe Deposit and Trust Company Building. (96) Nov. 10.
A Velocity-Reducing Drainage Outfall.* (14) Nov. 12.
New Refuse Destructor at Guildford, England. C. G. Mason. (Abstract of paper read before the Inst. of Mun. and County Engrs.) (14) Nov. 12.
Mechanical Features of the Blackstone.* (101) Nov. 15.
Proposed Sewage Tank at Guildford, Eng.* (96) Nov. 17.
The First Garbage Reduction Works Built by an American City; Columbus, Ohio.* I. S. Osborn. (13) Nov. 17; (14) Nov. 19.
Hot-Water Heating.* Frederick Dye. (Paper read before the Inst. of Heating and Ventilating Engrs.) (101) Nov. 19.
The Agricultural Use and Value of Sewage. J. A. Voelcker. (Abstract of paper read before the Assoc. of Mgrs. of Sewage Disposal Works.) (13) Nov. 24.
Sewage Disposal for a Federal Building.* (101) Nov. 26.
Milwaukee Garbage Destructor.* (64) Nov. 29.
Mechanical Appliances for Health and Safety in the Weaving Industry.* H. M. Crawford. (10) Dec.
A German Sanitary District and the Imhoff Sewage-Purification Tank.* Rudolph Hering, M. Am. Soc. C. E. (13) Dec. 1.
The Emschergenossenschaft and the Imhoff Tank.* Charles Saville. (13) Dec. 1.
The Jones Falls Covered Conduits and Boulevard, Baltimore.* (14) Dec. 3.
The Disposal of Trade Wastes. George A. Johnson. (Abstract of paper read before the N. J. San. Assoc.) (13) Dec. 8.
A New Method of Handling Sewage Sludge.* Karl Imhoff. (14) Dec. 10.
The North Trunk Sewer in Seattle.* (14) Dec. 10.
Le Département de la Seine et l'Epuration Bactérienne des Eaux d'Egout.* Mahieu. (43) Sept.
Die Kläranlage der Stadt Neuhaldensleben.* Rudolf Hauptner. (78) Nov. 15.

---

*Illustrated.

Structural.

Some Mooted Questions in Reinforced Concrete Design.* Edward Godfrey, M. Am. Soc. C. E. (54) Vol. 70.
Tests of Creosoted Timber. W. B. Gregory, M. Am. Soc. C. E. (54) Vol. 70.
The Ultimate Load on Pile Foundations: A Static Theory.* John H. Griffith, Assoc. M. Am. Soc. C. E. (54) Vol. 70.
Eccentrically-Loaded Columns. Walter Elsworthy Lilly. (63) Vol. 81.
The Physical Interpretation of Hardness as Measured by the Shore Scleroscope. Richard Henry Greaves. (63) Vol. 81.
Dixon's Silica-Graphite Paint.* Otis K. Stuart. (98) Oct.
Forms for Concrete (Pittsburgh Filtration Works).* J. D. Stevenson. (58) Oct.
Recent Retaining Wall Practice, City of Pittsburgh.* Chas. M. Reppert. (58) Oct.
Material Economics. T. D. Lynch. (58) Nov.
Placing Concrete Through Metal Pipes.* (67) Nov.
Stretford Gas Company and Their Works.* (66) Nov. 1.
Construction of Foundations for Electrical Machinery.* Bruce H. Page. (27) Nov. 3.
Efflorescence on Brick Work. A. F. Greaves-Walker. (From *Journal* of the Amer. Chem. Soc.) (13) Nov. 10; (86) Nov. 23.
Brick, Concrete and Steel Gasholder Tanks.* Herbert W. Alrich. (Abstract of paper read before the Amer. Gas Inst.) (14) Nov. 12; (24) Nov.; (66) Nov. 8.
Investigations on the Slip of Rods Imbedded in Concrete.* H. Burchartz. (14) Nov. 12.
Concrete vs. Wood Flooring for Machine Shops. James N. Heald. (41) Nov. 15.
Some Unit Costs of Constructing a Brick and Concrete Building. (86) Nov. 16.
New Rules of Measurement for Excavation and Concrete Work in Chicago. (86) Nov. 16.
Foundations of the Municipal Building, New York City.* (13) Nov. 17.
Metal Wall Forms for Concrete Houses.* (14) Nov. 19.
Tests to Determine the Effects of Frost on Concrete and Methods of Concrete Work in Freezing Weather.* (86) Nov. 23.
The Selection and Treatment of Alloy Steels for Automobiles. Henry Souther. (3) Dec.
Sheet Piling.* Ewing Matheson, M. Inst. C. E. (10) Dec.
Reinforced Concrete Pile.* Edward Molinn. (96) Dec. 1.
Further Tests on the Effect of Electric Currents Upon Concrete and Steel.* U. James Nicholas. (13) Dec. 1.
Heat Changes in Structural Materials.* James E. Howard. (Abstract from paper read before Nat. Assoc. of Mutual Insurance Companies.) (20) Dec. 1.
Puzzolan-Portland Cement; A Suggestion for an Improved Hydraulic Cement.* Edward Duryea. (13) Dec. 1.
The Effect of Fire on Building Materials.* James E. Howard. (Abstract of paper read before the Nat. Assoc. of Mutual Ins. Cos.) (14) Dec. 3.
Gypsum as a Fireproofing Material. (14) Dec. 3.
The Windsor Station Foundations, Montreal.* (14) Dec. 3.
Wood Preservation. A. L. Kuehn. (Abstract of paper read before the Central Elec. Ry. Assoc.) (17) Dec. 3.
Conveying and Depositing Concrete by Gravity Chutes.* (13) Dec. 8.
The Collapse of the Reinforced-Concrete Henke Building, Cleveland, Ohio.* (13) Dec. 8.
Largest Concrete Oil Reservoirs in the World.* Hamilton M. Wright. (46) Dec. 10.
The Substructure of the Bankers Trust Company's Building.* (14) Dec. 10.
Underpinning the Manhasset Building, New York.* (14) Dec. 10.
New Shops of Utah Light & Railway Company.* (17) Dec. 10.
Design of Two Large Reinforced Concrete Buildings.* M. E. Thomas. (14) Dec. 10.
The Effect of the Mold Material on Concrete Blocks. Carpenter. (Abstract from *Sibley Journal of Eng.*) (14) Dec. 10.
L'Assèchement des Sables Aquifères.* J. Roman. (31) Vol. 3, Pt. 3.
Consolidation Partielle des Terrains de la Butte Montmartre, à Paris.* E. Rivoalen. (35) Nov.
Elargissement du Goulot de la Gare Saint-Lazare; Murs de Soutenement le Long de Propriétés Privées.* Charles Rabut. (33) Nov. 5.
La Fatigue des Métaux et les Nouvelles Méthodes d'Essais.* Ch. Fremont. (33) Serial beginning Nov. 19.
Die Wiener Wohnungsverhältnisse und Vorschläge zur Verbesserung derselben.* Heinrich Goldemund. (53) Serial beginning Oct. 28.
Der Neubau des Reichsmilitärgerichtes am Lietzensee in Charlottenburg.* (51) Serial beginning Nov. 2.
Einige Eisenbetonbauten in Dänemark.* Emil Mogensen. (78) Nov. 15.
Ueber die Berechnung der dreistieligen Rahmenkonstruktionen.* B. Pollnow. (78) Nov. 15.
Flachgewölbe und ebene Platten zwischen Eisenträgern.* R. Saliger. (53) Nov. 25.

---

*Illustrated.

Topographical.

Riparian Boundaries. J. B. Davis. (Paper read before the Detroit Eng. Soc.) (1) Oct.
Insurance Surveying and Map Making.* R. P. Getty. (10) Nov.

Water Supply.

A Concrete Water Tower.* A. Kempkey, Jr., Jun. Am. Soc. C. E. (54) Vol. 70.
The Water Supply of the El Paso and Southwestern Railway From Carrizozo to Santa Rosa, N. Mex.* J. L. Campbell, M. Am. Soc. C. E. (54) Vol. 70.
Notes on the Sheffield Water Supply, and Statistics Relating Thereto. Leonard Swaine Marsh, M. Inst. C. E. (63) Vol. 81.
Statistical and Experimental Data on Filtration. William Ralph Baldwin-Wiseman, M. Inst. C. E. (63) Vol. 81.
Contractors' Plants, Types, Layout and Methods of Operation. (Pittsburgh's Filtration Works).* Frederick E. Field. (58) Oct.
The Hydro-Electric Power Plant on the Jhelum River in Kashmir, India.* Heinrich Homberger. (Paper read before the Tech. Soc. of the Pacific Coast.) (1) Nov.
Low-Head Water Power at Manhattan, Kan.* (27) Nov. 3.
Excavation of the Walkill Pressure Tunnel, Catskill Water Supply to New York City, American Record for Hard Rock Tunnel Driving.* (86) Nov. 9.
Factors to be Considered in Valuing a Water Power. (96) Nov. 10.
The La Prele Dam; a 130-Ft. Hollow Reinforced Dam near Douglas, Wyoming.* (13) Nov. 10.
Feed Water for Steam Boilers.* Edward Ingham. (22) Nov. 11.
Impressions of Recent Hydroelectric Practice in Switzerland.* W. F. Durand. (14) Nov. 12.
Some Notes on the History of Water Purification. (14) Nov. 12.
Making Continuous Concrete Pipe.* (46) Nov. 12.
Sixty Years of Rainfall in California.* Alexander G. McAdie. (Abstract from the *Pacific Rural Press.*) (103) Nov. 12.
Operating Results of the Antietam and Egelman Filters at Reading. (14) Nov. 12.
Quadrant Sluices for Canal Regulators on Murrumbidgee Irrigation Project. (14) Nov. 12.
Electrical Pumping Plant for Irrigation in Utah.* (14) Nov. 12.
Examples of Practice in Using Check Valves to Prevent Contamination from Secondary Water Supplies.* (86) Nov. 16.
The Decision in the Long-Delayed Peoria Electrolysis Suit. (13) Nov. 17.
The Loch Arklet Extension of the Glasgow Water Supply.* (12) Nov. 18.
Water-Filtering Plant at the Parkgate Works. (22) Nov. 18.
Experiments with Model Spillways, Barren Jack Dam. L. A. B. Wade. (Abstract of paper read before the Sydney Univ. Eng. Soc.) (14) Nov. 19.
A Mechanical Water Recorder.* (46) Nov. 19.
Water Supply for a Public Bath.* (101) Nov. 19.
A Buttressed Masonry Dam Reinforced with Steel I-Beams.* F. S. Tainter, M. Am. Soc. C. E. (13) Nov. 24.
The High Falls Development of the Peshtigo River in Northern Wisconsin.* (27) Nov. 24.
Water-Power Possibilities in Southeastern Alaska.* John C. Hoyt, M. Am. Soc. C. E. (13) Nov. 24.
Graphic Calculation of the Flow of Water in Pipes.* T. G. Bocking. (12) Nov. 25.
Costs of Operating Filters, Reading, Pa., Water-Works. (86) Nov. 30.
The New 30-in. Cast Iron Conduit from Lake Skaneateles to Syracuse Water Works.* M. B. Palmer. (86) Nov. 30.
Hydro-Electric Practice. H. A. von Schon, M. Am. Soc. C. E. (60) Dec.
The Function of the State Engineer in the Arid and Semi-Arid States. Samuel H. Lea, M. Am. Soc. C. E. (Abstract from paper read before the Nat. Irrig. Congress). (13) Dec. 1.
Water Storage *versus* Storage Batteries. A. W. Barham. (73) Dec. 2.
Water Power Regulation in Pennsylvania. Farley Gannett. (14) Dec. 3.
Something About Pipe Covering. (46) Dec. 3.
Electric Hot Water Supply System.* Joseph B. Baker. (46) Dec. 3.
Water Filtration and Typhoid Fever. (14) Dec. 3.
Compressed Air Transmission Tables. Frank Richards. (64) Dec. 6.
Large Portable Plant for Crushing, Mixing and Placing Concrete on Catskill Aqueduct.* (86) Dec. 7.
Methods and Cost of Sinking and Lining a Dug Well on Long Island. J. L. Ingle, Jr. (86) Dec. 7.
Cost of Operating Filters for Twelve Months, Philadelphia Water Supply. (86) Dec. 7.
Outline of Sanitary Waterworks in the Province of Quebec. James O. Meadows. (96) Dec. 8.
Report of Duty Trial on the Six Million Imperial Gallon Pumping Engine at the High-Level Pumping Station, Toronto Waterworks.* Robert W. Angus. (From *Applied Science*). (96) Dec. 8.

---

*Illustrated.

Water Supply—(Continued).

The Development of the Municipal Water-Works of Spokane, Wash., and the Addition of an Electric Pumping Station.* Alexander J. Lindsay. (13) Dec. 8.
Corrosion of Hot-Water Piping in Bath-Houses. Iva H. Woolson, M. Am. Soc. M. E. (13) Dec. 8.
An Electrically Operated Municipal Pumping Station.* Alexander J. Lindsay. (14) Dec. 10.
Filter Troubles Caused by Micro-Organisms at Louisville. (14) Dec. 10.
La Stérilisation de Grandes Quantités d'Eau par les Rayons Ultraviolets.* Max de Recklinghausen. (33) Nov. 5.
Die Kern River-Anlage No. 1 der Edison Electric Company in Los Angeles, Kalifornien.* Otto Gruenberger. (97) Serial beginning Sept. 5.
Entwurf eines Wasserkraftwerkes im Gebiet der Murg oberhalb Forbach.* Rehbock. (97) Sept. 20.
Die Wasserversorgung der Stadt Noworossijsk. Oskar Lieven-Noworossijsk. (52) Oct. 15.
Der Gewitterregen vom 13. Juni, 1910.* W. Voit. (53) Nov. 25.

Waterways.

Reinforced Concrete Pier Construction. Eugene Klapp, M. Am. Soc. C. E. (54) Vol. 70.
Riparian Boundaries. J. B. Davis. (Paper read before the Detroit Eng. Soc.) (1) Oct.
The Deep Waterway from St. Louis to Cairo: A Review of Seven Proposed Plans for Securing a Fourteen-Foot Waterway.* J. W. Woermann, M. Engrs. Club, St. Louis. (Paper read before the Engrs. Club St. Louis.) (1) Nov.
Electricity and the Panama Canal.* John Geo. Leigh. (26) Serial beginning Nov. 4.
Design for a Granite Masonry Sea Wall at Boston, Mass.* (86) Nov. 9.
Roofing for Ferry-Slip Piles.* (19) Nov. 12.
The Siphon Lock on the New York State Barge Canal at Oswego, N. Y.* D. A. Watt, M. Am. Soc. C. E. (13) Nov. 17.
Placing a Floating Concrete Crib for a Lighthouse.* (14) Nov. 19.
Difficult Work on the Naos Breakwater on the Panama Canal.* (From *Canal Record.*) (14) Nov. 19.
Separately Molded Concrete Members for a Sea Wall. (Abstract from *Concrete and Constructional Engineering.*) (14) Nov. 19.
Methods of Excavating Canal Prism Using a Bridge Conveyor Excavator, with Costs of Work for Twenty-Four Consecutive Months.* (86) Nov. 23.
Some Costs of Channeling Rock on the New York State Barge Canal. (86) Nov. 23.
Extracts from the Annual Report of the Isthmian Canal Commission for the Year ending June 30, 1910.* (13) Nov. 24; (86) Nov. 23.
Wire Drag Work of the United States Coast and Geodetic Survey.* (13) Dec. 1.
The Cost of Concrete on the Panama Canal Locks. (14) Dec. 3.
Methods and Costs of Concrete Work at the Gatun Locks of the Panama Canal.* (86) Dec. 7.
Permeable Dike Construction for Protecting a Bridge Substructure, Chicago, Milwaukee & St. Paul Ry.* (86) Dec. 7.
Movable Dams on the New York State Barge Canal.* (13) Dec. 8.
The New Canal Gate at Sault Ste. Marie.* (14) Dec. 10.
Le Danube dans la Basse Autriche.* Armand. (43) Sept.
Note sur la Construction de la Jetée de Djidjelli.* Daujon. (43) Sept.
Réparations des Avaries Survenues au Barrage de Gigny sur la Saône.* Henri Tavernier. (43) Sept.

---

*Illustrated.

PROGRESS REPORT OF SPECIAL COMMITTEE ON BITUMINOUS MATERIALS FOR ROAD CONSTRUCTION.

To the American Society of Civil Engineers:

Gentlemen:—Your Special Committee on "Bituminous Materials for Road Construction" respectfully presents the following Progress Report.

Through the courtesy of your Board a special meeting to discuss the many problems of modern highway engineering was held, under the auspices of the Committee, on January 21st, 1910, at the House of the Society. About one hundred engineers, highway officials, and chemists attended the meeting. The discussion covered progress along many of the lines in which the Committee is interested, and thus was of considerable value to your Committee as well as affording an opportunity for an exchange of opinions and results among those present.

The Secretary of this Committee has spent nearly a year abroad studying European methods employed in the construction and maintenance of bituminous surfaces and bituminous pavements. The Chairman has also made a shorter trip, partly for this purpose. The Committee is advised that it will receive reports and assistance in its work from eminent engineers in England and France. The work of your Committee attracted sufficient attention from the Permanent International Association of Road Congresses to induce this organization to publish in French, German, and English, the three forms issued by the Committee and to distribute them to the membership of the Permanent Association and of the Second International Road Congress, which was held at Brussels last August. It should be appreciated that although European engineers have been constructing and maintaining bituminous roads since the beginning of the present century, your Board has authorized the first systematic work which has been undertaken in the endeavor to place the use of bituminous materials in road construction upon a scientific basis.

An encouraging number of reports have already been received from the Park, Municipal, County, and State Engineers of this country. The Committee having felt the necessity of a supplementary report covering the condition of the road construction previously described on the Committee's forms, has prepared and distributed a form for this second report.

While some tentative preliminary conclusions might be drawn by the Committee from its work to date, more especially relative to surface treatments of roads with bituminous materials, your Committee deems it advisable to withhold conclusions until the accumulation of evidence warrants the publication of facts rather than theories.

The investigations and correspondence of the Committee have revealed such a variety of opinions and specifications concerning the use of bituminous materials in road construction and maintenance as to emphasize the value of the action of your Board in appointing a Committee to investigate the above subject.

We have the honor to be,

Very respectfully,

W. W. Crosby, *Chairman.*
H. K. Bishop.
A. W. Dean.
A. H. Blanchard, *Secretary.*

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XXXVI.

JANUARY TO DECEMBER, 1910.

NEW YORK:
PUBLISHED BY THE SOCIETY.
1910.

Entered according to Act of Congress, by the AMERICAN SOCIETY OF CIVIL ENGINEERS, in the Office of the Librarian of Congress at Washington.

NOTE.—This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

INDEX.

A.

"A Concrete Water Tower," presented and discussed, 159.

Abbott, Hunley. — Transferred to Grade of Associate Member, 532.

Accessions to the Library, 21, 96, 129, 177, 222, 321, 406, 456, 498, 541.

Ackemann, Henry Conrad.—Elected a Junior, 53.

Ackerman, Arthur Pope.—Elected a Junior, 271.

Adams, Charles Robert.—Elected an Associate Member, 52.

Aegerter, Albert August.—Elected an Associate Member, 121.

Alderson, William Howard.—Transferred to Grade of Associate Member, 122.

Alexander, Leon Barton.—Elected a Junior, 489.

Alford, William Valorus.—Elected an Associate Member, 488.

Allard, T. T.—Discussion by, 487.

Allen, Andrews.—Discussion by, 119.

Allen, Chester Salisbury.—Transferred to Grade of Associate Member, 448.

Allen, Harold Dayton.—Transferred to Grade of Associate Member, 532.

Allen, Henry C.—On Nominating Committee, 50, 58.

Allen, Kenneth.—Discussion by, 213.

Allen, Raymond Cleaveland. — Elected an Associate Member, 530.

Allison, William Franklin. — Elected an Associate Member, 446.

Amendment to Constitution.—Text of Proposed, 492.

American Institute of Mining Engineers.—Announcement Relating to Meeting of, at Canal Zone, 395.

Anderberg, Edward.—Transferred to Grade of Associate Member, 122.

Anderson, David Guy.—Transferred to Grade of Member, 215.

Anderson, George Gray.—Paper by, 119.

Andress, Harry R.—Elected an Associate Member, 266.

Andrews, Horace.—On Publication Committee, 55.

Andros, Frederic William.—Transferred to Grade of Member, 397.

Angel, Floyd Dwight.—Elected an Associate Member, 446.

Angier, W. E.—On Committee of Arrangements for Annual Convention, 165.

Announcements, 6, 91, 124, 165, 217, 315, 400, 449, 491, 534.

Annual Convention, 42d.—Time and Place Announced, 161, 164; Appointment of Committees of Arrangements for, 165; Minutes of Meetings of, 269, 270, 274; Excursions and Entertainments at, 308; Attendance at, 310.

Annual Convention, 43d.—Report of Secretary Relative to Time and Place for Holding, 269, 287.

Annual Meeting.—Minutes of, 49, 57; Announcements at, 51, 75; Excursions and Entertainments at, 79; Attendance at, 79.

Archbald, James.—Death announced, 488.

Armstrong, Alexander Floyd.—Transferred to the Grade of Member, 532.

Ash, Louis Russell.—Transferred to Grade of Member, 397.

Atwell, Harry Hurd.—Transferred to Grade of Associate, 4.

Atwood, Chester Ely.—Elected a Junior, 53.

Atwood, T. C.—Discussion by, 529.

Atwood, William Greene.—Transferred to Grade of Member, 489.

Averill, James Leland.—Elected an Associate Member, 530.

Avery, Frederick Hague.—Elected a Member, 266.

Awoyama, Akira.—Elected an Associate Member, 161.

Ayer, Frederic Eugene.—Elected an Associate Member, 266.
Ayres, John Henry.—Elected an Associate Member, 488.
Ayres, Willis Edward.—Elected a Member, 266.

Backus, Murray James.—Elected a Junior, 447.
Bacon, Arthur Whittemore. — Transferred to Grade of Associate Member, 216.
Baffrey, Charles Raymond.— Elected a Member, 2.
Bailey, Clifton George.—Elected a Junior, 397.
Baines, William Henry.—Elected a Junior, 397.
Bake, William Sibson.—Elected an Associate Member, 2.
Baker, Ned Duncan.—Elected a Junior, 531.
Ball, Ernest Stearns.—Death announced, 2.
Bamford, William Brokaw.—Paper by, 51; Transferred to Grade of Member, 268.
Banta, Russell Vincent.—Elected a Junior, 267.
Barker, Louis H.—Paper by, 445.
Barlow, James Evans.—Transferred to Grade of Associate Member, 122.
Barnard, Elmer Ellsworth.— Transferred to Grade of Associate Member, 216.
Barnard, John Fiske.—Death announced, 120.
Barnes, Frank William, Jr.— Elected an Associate Member, 530.
Barnes, Osgood Frost.—Elected a Member, 270.
Barney, William Joshua.—Elected a Junior, 162.
Barr, Joseph Carroll.—Transferred to Grade of Member, 489.
Barrett, Robert Edward.—Transferred to Grade of Associate Member, 532.
Batchelder, Benjamin Franklin.— Elected an Associate Member, 2.
Bates, John Schuyler.—Elected an Associate Member, 121.
Bates, Onward.—Presides at Meeting, 49; On John Fritz Medal Board of Award, 55.
Bates, Philo H.—Discussion by, 119.
Baum, Harry William.—Elected a Member, 446.
Beard, Vivian Dangerfield.—Elected a Junior, 162.
Bebout, Guy Burnet.—Elected an Associate Member, 270.
Becker, Elvin Jay.—Transferred to Grade of Associate Member, 122.
Bedford, Thomas Archibald. — Elected a Member, 396.
Beebe, John Cleaveland.—Elected a Junior, 489.
Behrman, Isadore.—Elected a Junior, 447.
Belknap, William E.—Elected Director, 51, 77; On Publication Committee, 55; Presides at Meeting, 265.
Bell, Howard Fred.—Elected a Junior, 267.
Belzner, Theodore.—Transferred to Grade of Associate, 216.
Benham, Webster Lance.—Elected an Associate Member, 161.
Bensel, John A.—Elected President, 51, 77; Address by, 51, 78, 269, 277; Presides at Meeting, 159, 160, 266, 269, 270, 274, 487, 530. On Committee on the Licensing of Civil Engineers, 171.
Bentley, John Clark.—Elected an Associate Member, 267.
Berthelet, J. R.—Resignation accepted, 4.
Bevan, Lynne John.—Elected an Associate Member, 214.
Beyer, Albin H.—Discussion by, 159.
Bhagwat, Shanker Ramchandra.— Elected a Junior, 447.
Bigelow, William Walter.—Elected a Junior, 53.
Binckley, George Sydney.—Elected a Member, 161.
Binford, Charles Munnerlyn.— Elected an Associate Member, 530.
Bingham, Clarence Arminger.— Transferred to Grade of Associate Member, 4.
Bischoff, Julius Montgomery. — Elected an Associate Member, 2.
Bixby, William Flint.—Transferred to Grade of Associate Member, 163.

Black, Ernest Bateman.—Elected an Associate Member, 488.
Black, R. P.—Paper by, 395.
Blanchard, Arthur Clarence Douglas.—Elected an Associate Member, 161.
Blanchard, Murray.—Transferred to Grade of Member, 532.
Blickle, Herman Renner.—Elected a Member, 488.
Blodgett, John.—Transferred to Grade of Member, 489.
Blum, Louis Philip.—Elected a Member, 266.
Board of Direction.—Report of, 11, 49, 57; Resolution of, Relative to Status of Civil Engineers in Engineer Corps of the United States Army, 123; Resolution of, Relative to Proposed Legislation on the Licensing of Civil Engineers, 160, 164, 171; Report of, Relative to Appointment of Proposed Committee on the Preservation of Wood, 269, 273, 282.
Boig, Alexander Fletcher.—Elected a Junior, 489.
Boller, Alfred P.—Nominated as Vice-President, 450.
Bolton, Frank Leonard.—Elected a Junior, 271.
Bond, Paul Stanley.—Elected a Member, 530.
"Bond-Friction-Resistance in Reinforced Concrete," presented and discussed, 530.
Boniface, Arthur.—Transferred to Grade of Associate Member, 448.
Booth, Arthur Allen.—Elected a Member, 270.
Boring, W. A.—Discussion by, 52.
Bornefeld, Charles Fowler. — Elected a Junior, 267.
Bortin, Harry.—Elected a Junior, 397.
Boude, Philip Bethel.—Elected an Associate Member, 121.
Bourguignon, Joseph.—Elected an Associate Member, 267.
Bowles, Charles William.—Elected an Associate Member, 396.
Bowman, A. L.—Presides at Meeting, 446, 529.
Bowman, W. L.—Discussion by, 52.
Brace, James H., Francis Mason, and S. H. Woodard.—Paper by, 1.
Brackett, Dexter. — On Library Committee, 55.
Brann, Emmett Raymond.—Elected a Junior, 531.
Branne, J. S.—Discussion by, 119.
Breed, Oliver Clark.—Elected a Member, 396.
Brogan, Thomas Byrnes.—Elected an Associate Member, 52.
Bronson, Howard Franklin. — Elected a Junior, 489.
Brosius, Albert Marshall.—Elected a Member, 121.
Brown, Frank Dudley.—Elected a Member, 446.
Brown, Harry William.—Elected an Associate Member, 161.
Brown, Joseph Henry, Jr.—Elected an Associate, 271.
Brown, Linus Weed.—Death announced, 163.
Brown, Robert Huse.—Transferred to Grade of Associate Member, 163.
Brown, Seymour Dewey.—Elected an Associate Member, 446.
Brown, Stephen Pearson.—Transferred to Grade of Member, 490.
Brown, W. L., and B. H. M. Hewett. —Paper by, 266.
Brown, Walter Henry.—Elected a Member, 266.
Bruce, John Augustus.—Elected an Associate Member, 396.
Bruner, Abraham.—Elected a Member, 121.
Bruntlett, Eugene Harry.—Transferred to Grade of Associate Member, 272.
Bryant, Byron Harkness.—Elected a Member, 396.
Buchanan, Nathan Booker. — Elected a Junior, 122.
Budd, Robert Dunn.—Elected a Member, 446.
Buehler, Walter.—Transferred to Grade of Member, 3.
Buel, Emott Davis.—Elected a Member, 270.
Buell, Walter Augustus.—Elected a Junior, 447.
Buettner, Otto George Henry.—Elected a Junior, 267.
"Building Agreements," presented and discussed, 51.
Bullen, Roy.—Transferred to Grade of Associate Member, 122.

Bunker, Paul D.—Resignation accepted, 4.
Bunker, Stephen Sans.—Elected an Associate Member, 446.
Burger, William Henry.—Elected a Member, 488.
Burke, Hubert Francis Daubeny.—Elected a Member, 52.
Burke, Ralph Haney.—Transferred to Grade of Associate Member, 448.
Burnham, D. H.—Lecture by, 270.
Burns, Walter Elliott.—Transferred to Grade of Associate Member, 532.
Burr, William H.—Discussion by, 160; On Committee on the Licensing of Civil Engineers, 171.
Burroughs, Frederic.—Transferred to Grade of Associate Member, 216.
Burroughs, Hector Robins.—Transferred to Grade of Associate Member, 398.
Burt, Luther Harold.—Elected an Associate Member, 488.
Bush, Adam Leonard.—Elected an Associate Member, 446.
Bush, Lincoln.—Discussion by, 2.
Busse, Franz August.—Elected an Associate Member, 161.
Butler, George.—Elected an Associate Member, 396.
Buxton, Clifford.—Death announced, 54.

Cadle, Charles Longford.—Elected an Associate Member, 488.
Cadwallader, Wallace Laird.—Elected a Junior, 397.
Caldwell, Fred Edward.—Transferred to Grade of Associate Member, 53.
Calhoun, David Adams.—Transferred to Grade of Associate Member, 268.
Calkins, Charles Dow.—Elected a Junior, 162.
Campbell, J. L.—Paper by, 214.
Carlin, Joseph Patrick.—Transferred to Grade of Member, 268.
Caro, Phillip.—Elected an Associate Member, 488.
Carpenter, A. W.—Discussion by, 487.
Carpenter, John Earl.—Resignation accepted, 4.
Carr, Dean Orrice.—Elected an Associate Member, 446.
Carter, W. J.—Appointed to Canvass Ballot for Officers, 49, 57.
Cartlidge, C. H.—On Committee of Arrangements for Annual Convention, 165.
Cartwright, Henry Hart.—Elected a Junior, 447.
Cary, Richard Lucius.—Elected a Junior, 271.
Case, George Wilkenson.—Elected an Associate Member, 396.
Caspari, Frederick William.—Elected a Junior, 489.
Cefalu, Frank Dominic.—Elected a Junior, 162.
Cement, Committee on Uniform Tests of.—Majority and Minority Reports of, 50, 66.
Chandler, Elwyn Francis.—Elected an Associate Member, 52; Discussion by, 530.
Chanute, Octave.—Death announced, 532.
Chappell, Claude Edward.—Transferred to Grade of Associate Member, 398.
Chase, Frank David.—Elected an Associate Member, 270.
Chassaing, Charles Willis.—Elected an Associate Member, 396.
Chenoweth, Alexander C.—Discussion by, 265.
Chiba, Toshitomo.—Transferred to Grade of Associate Member, 398.
Christian, Charles Meriwether.—Elected an Associate, 489.
Church, George Earl.—Death announced, 54.
Churchill, Charles S.—On Finance Committee, 55.
Civil Engineers, Licensing of.—Telegram Relative to Proposed Legislation on, 160; Statement of Secretary Relative to Action of the Society on Proposed Legislation on, 160, 171; Resolution of the Board of Direction Relative to Proposed Legislation on, 160, 164, 171; Discussion on, 160; Resolution Relative to the Appointment of a Committee on, 161; Appointment of Committee

on, 171; Report of Committee on, 269, 299; Discussion on Report of Committee on, 303; Appointment of Corporate Members in each State to Co-operate with Board in Relation to, 448.

Civil Engineers, Status of in Engineer Corps of United States Army.—Resolution of Board Relative to, 123; Bill Relative to, 166.

Clark, Arthur Edward.—Elected an Associate Member, 446.

Clark, Arthur Pierson.—Elected an Associate Member, 530.

Clarke, George C.—Paper by, 214, 445; Nominated as Director, 450.

Clarke, St. John.—Discussion by, 2.

Cleveland, Henry Burdett.—Elected an Associate Member, 267.

Clifford, Walter W.—Discussion by, 159.

Cochrane, Victor Hugo.—Transferred to Grade of Member, 532.

Coe, Robert.—Elected an Associate Member, 396.

Cole, Harry Outen.—Transferred to Grade of Member, 215.

Coleman, Lester Lyman.—Elected a Junior, 267.

Collingwood Prize.—Award of, 52, 56.

Collins, Francis Winfield.—Transferred to Grade of Associate Member, 398.

Collins, Stewart Garfield.—Elected an Associate Member, 488.

Colman, James Blaine Thomas.—Elected a Junior, 489.

Colorado Association of Members of the American Society of Civil Engineers.—Abstract of Minutes of Meetings of, 10, 95, 128, 174, 219, 317, 318, 454, 495, 538; Correspondence with, Relative to the Appointment of a Special Committee on the Preservation of Wood, 120.

Coltman, Robert, 3d.—Elected an Associate Member, 446.

Committee on Bituminous Materials for Road Construction.—Progress Report of, 50, 62, 569.

Committee on Concrete and Reinforced Concrete.—Progress Report of, 51, 76.

Committee on Engineering Education.—Progress Report of, 50, 65.

Committee on Finance.—Appointment of, 55.

Committee on Library.—Appointment of, 55.

Committee on Nominations.—Appointment of, 50, 57; Presents List of Nominees, 450.

Committee on Publications.—Appointment of, 55.

Committee on Rail Sections.—Progress Report of, 50, 62; Final Report of, 269, 291.

Committee on Steel Columns and Struts.—Progress Report of, 50, 59; Discussion on Progress Report of, 60.

Committee on the Licensing of Civil Engineers.—Resolution Relative to Appointment of, 161; Appointment of, 171; Report of, 269, 299; Discussion on Report of, 303.

Committee on the Preservation of Wood.—Correspondence Relative to Appointment of, 120; Resolution Relative to Appointment of, 121; Report of Board of Direction Relative to Appointment of, 269, 273, 282; Discussion on Appointment of, 283.

Committee on the Status of the Metric System in the United States.—Final Report of, 50, 69.

Committee on Uniform Tests of Cement.—Majority and Minority Reports of, 50, 66.

Committee to Recommend the Award of Prizes.—Report of, 52, 55.

Committees of Arrangements for Annual Convention, 42d.—Appointment of, 165.

Comstock, Harold Dearborn.—Elected an Associate Member, 161.

Concrete and Reinforced Concrete, Committee on.—Progress Report of, 51, 76.

Connell, Henry Leo.—Elected an Associate Member, 2.

Connick, Harris De Haven.—Transferred to Grade of Member, 53.

Connor, William Durward.—Transferred to Grade of Member, 268.

Conover, Charles E.—Elected a Member, 488.

Conrow, Herman.—Resignation accepted, 4.

Constitution, Proposed Amendment to.—Text of, 492.

Cook, Horace Arthur.—Elected an Associate Member, 214.

Cook, John Henry.—Transferred to Grade of Member, 3.

Cooper, William H.—Resignation accepted, 4.

Cope, Erle Long.—Transferred to Grade of Associate Member, 532.

Corbett, J.—Discussion by, 121.

Cornell, John Wesley.—Elected an Associate Member, 270.

Cornish, Lorenzo Dana.—Transferred to Grade of Member, 271.

Couchot, George John.—Elected an Associate Member, 214.

Couchot, Maurice C.—Discussion by, 159.

Courtenay, William H.—Nominated as Director, 450.

Cowles, L. S.—Appointed Teller to Canvass Ballot for Officers, 49, 57.

Cowles, William Pierce.—Transferred to Grade of Member, 215.

Coyne, Harry Lewis.—Transferred to Grade of Associate Member, 272.

Cox, Charles Barrows.—Elected an Associate Member, 396.

Crandall, Lynn.—Elected a Junior, 531.

Craven, Jay Allen.—Elected a Junior, 267.

Crawley, Ernest Willard.—Transferred to Grade of Associate Member, 398.

Cresson, B. F., Jr.—Paper by, 161.

Croasdale, Laurence Brodhead.—Elected a Junior, 267.

Crockard, Frank Hearne.—Elected a Member, 446.

Crosby, W. W.—Discussion by, 119.

Crow, Edward.—Transferred to Grade of Associate Member, 272.

Crowe, Francis Trenholm.—Elected an Associate Member, 214.

Cuddeback, Allan Winter.—Transferred to Grade of Member, 122.

Cuntz, William Cooper.—Elected an Associate, 397.

Curfman, Lawrence Everett.—Elected an Associate Member, 530.

Current Engineering Literature.—31, 102, 142, 193, 237, 352, 419, 471, 511, 549.

Currey, Jesse Albert.—Elected an Associate, 53.

Currey, John Waggoner.—Elected a Junior, 397.

Currier, Albert Moore.—Elected an Associate Member, 214.

Curry, C. W.—Resignation accepted, 4.

Curtis, Loren Bradley.—Transferred to Grade of Member, 490.

Cushing, Bruce Lincoln.—Elected an Associate Member, 446.

Cutler, Alvin Sayles.—Elected an Associate Member, 52.

Cutler, Leon George.—Elected a Junior, 162.

Cutting, George Warren, Jr.—Elected an Associate Member, 214.

Dallis, Park Andrew.—Transferred to Grade of Member, 4.

Daly, David Augustus.—Elected an Associate Member, 267.

Dambach, William Nicholas.—Elected an Associate Member, 396.

Darnell, James Lee.—Elected a Member, 446.

Davenport, Royal William.—Elected a Junior, 447.

Davis, J. L.—Discussion by, 119.

Davis, Roland Parker.—Elected a Junior, 122.

Davison, Allen Stewart.—Elected a Junior, 122.

Dawley, Edwin Peleg.—Death announced, 488.

Dawson, Jay Bosworth.—Elected an Associate Member, 271.

Day, Warren Ellis.—Elected a Junior, 531.

Day, Warren French.—Elected an Associate Member, 530.

Day, William Peyton.—Transferred to Grade of Associate Member, 122.

Decrow, David Augustus.—Elected a Member, 446.

Degen, Otto William.—Elected a Member, 161.

Demorest, George Myron.—Elected an Associate Member, 271.

Denise, Charles Meirs.—Elected a Member, 214.
Derr, Homer Munro.—Elected an Associate Member, 3.
Derrick, Clarence.—Elected an Associate Member, 446.
Derrick, Guy Hamilton.—Elected a Member, 214.
DeYoung, Isaac.—Transferred to Grade of Member, 4.
Dickerson, John Thomas.—Elected an Associate Member, 161.
Dickinson, William Dewoody.—Elected an Associate Member, 214.
Diehl, George Conrad.—Elected a Member, 266.
Dietrich, William Henry.—Elected an Associate Member, 3.
Dimock, Arthur Herbert.—Elected a Member, 266.
d'Invilliers, Camille Stanislaus—Death announced, 54.
Dittoe, William Henry.—Elected a Junior, 215.
Dobson, Guy Ellsworth.—Elected an Associate Member, 267.
Dodds, David Metheny.—Elected a Junior, 489.
Doolittle, Frederick William.—Elected a Junior, 162.
Dow, William Grear.—Elected an Associate Member, 530.
Downs, Lawrence Aloysius.—Elected a Member, 396.
Doying, William Albert Edward.—Elected an Associate Member, 52.
Doyle, Edmund Henry.—Elected an Associate Member, 488.
Doyle, John Stephen.—Transferred to Grade of Member, 215.
Drager, Walter Louis.—Elected a Junior, 215.
Dudley, Charles Benjamin.—Death announced, 4.
DuMoulin, Walter Louis.—Elected a Junior, 53.
Duncan, Dorsey Berry.—Elected an Associate Member, 267.
Duncan, James Harper.—Transferred to Grade of Associate Member, 53.
Dunglinson, George, Jr.—Elected an Associate Member, 488.
Dunlop, Samuel Campbell.—Elected an Associate Member, 530.
Dunn, Oswald Thorpe.—Elected an Associate Member, 396.
Dygert, Harry Isaiah.—Elected an Associate Member, 214.

Ebashi, Teiji.—Elected an Associate Member, 446.
Eber, John William.—Transferred to Grade of Member, 397.
Eberly, Clarence Frederick.—Elected an Associate Member, 396.
Eddy, Adolphus James.—Elected a Junior, 531.
Eddy, Albert Clark.—Elected a Member, 530.
Edwards, Dean Gray.—Transferred to Grade of Associate Member, 54.
Edwards, Harold.—Elected an Associate Member, 396.
Edwards, Llewellyn Nathaniel.—Elected an Associate Member, 121.
Edwards, Warrick Rigeley.—Transferred to Grade of Member, 397.
Egbert, Warren.—Elected an Associate Member, 488.
Ehle, Boyd.—Transferred to Grade of Member, 53.
Eide, Torris.—Elected a Junior, 397.
Eitzen, Arthur Robert.—Transferred to Grade of Associate Member, 490.
Elliott, James William.—Transferred to Grade of Member, 271.
Ellis, Herbert Cram.—Elected a Junior, 162.
Ellms, Joseph W.—Discussion by, 121.
Ellstrom, Victor Edwin.—Elected an Associate Member, 530.
Emerson, Raffe.—Elected an Associate Member, 271.
Emigh, John H.—Death announced, 54.
Emigh, William Chester.—Elected a Junior, 267.
Endicott, Mordecai T.—Nominated as President, 450.
Engineering Education, Committee on.—Progress Report of, 50, 65.
English, C. C.—Resignation accepted, 4.
Ensey, Richard Fahnestock.—Elected an Associate Member, 161.

Ensign, Guert William.—Transferred to Grade of Member, 397.
Entemann, Paul Max.—Elected a Junior, 122.
Erdmann, Earl Edwin.—Death announced, 216.
Estep, Josiah Madison.—Elected a Member, 121.
Evans, W. A.—Address by, 269, 274.

Fanning, John T.—Elected Vice-President, 51, 77; On Library Committee, 55.
Farley, Philip Patrick.—Transferred to Grade of Member, 53.
Farnham, Robert, Jr.—Transferred to Grade of Member, 162.
Farrington, Harold Phillips.—Elected a Junior, 162.
"Federal Investigations of Mine Accidents, Structural Materials, and Fuels, at the United States Testing Station, Pittsburg, Pa.," presented and discussed, 213.
Ferris, Raymond West.—Elected a Junior, 215.
Fertig, Jerome Henry.—Transferred to Grade of Associate Member, 122.
Field, Frederick Elbert.—Transferred to Grade of Member, 397.
Filley, Oliver Dwight.—Elected a Member, 161.
Finance Committee.—Appointment of, 55.
Fischer, Guillermo Gustavo.—Transferred to Grade of Associate Member, 532.
FitzGerald, Desmond.—Presents Report of Special Committee on Engineering Education, 50, 64.
Fitzgerald, Walter Lewis.—Elected an Associate Member, 214.
Fitzpatrick, James Raymond.—Elected an Associate Member, 267.
FitzRandolph, William Sheppard.—Transferred to Grade of Associate Member, 398.
Fleeger, Burtner.—Elected a Junior, 531.
Foote, Arthur DeWint.—Elected Director, 51, 77.
Forbes, Francis Bonner.—Elected a Junior, 215.
Ford, Harry Clifford.—Transferred to Grade of Associate Member, 54.
Ford, Howard Carlton.—Transferred to Grade of Associate Member, 268.
Ford, William Ellis.—Elected an Associate Member, 121.
Forgie, James.—Presents paper, 266.
Foss, John Harrison.—Transferred to Grade of Associate Member, 448.
Fox, William Frederick.—Elected a Junior, 162.
Fraser, Charles E.—Discussion by, 2.
Frederickson, John Henry.—Elected a Member, 488.
French, J. B.—Discussion by, 487.
Frisbie, Henry Charles.—Elected a Junior, 447.
Frizell, Joseph Palmer.—Death announced, 266.
Fry, Alfred Brooks.—Elected a Member, 530.
Fuller, Almon Homer.—Transferred to Grade of Member, 216.
Fuller, William B.—Discussion by, 121.
Fulton, James Edward.—Elected a Member, 446.
Fulweiler, Walter Herbert.—Elected an Associate Member, 488.
Fuqua, Paul David.—Elected an Associate Member, 446.

Gadd, Robert Foster.—Elected a Member, 396.
Gaines, R. H.—Discussion by, 119.
Gard, Hermon Yancy.—Elected a Junior, 3.
Gardiner, F. W.—Discussion by, 487.
Gardiner, John Peden.—Transferred to Grade of Member, 397.
Gardner, W. L.—On Committee of Arrangements for Annual Convention, 165.
Garnett, Benjamin Jay.—Elected a Junior, 489.
Garrett, John Thomas.—Transferred to Grade of Member, 397.
Garrigues, Henry Haydock.—Transferred to Grade of Associate Member, 272.
Garver, Neal Bryant.—Elected an Associate Member, 214.

Garvey, Victor Hugo.—Elected a Junior, 489.

Gass, Elmer John.—Elected an Associate Member, 531.

Gaumer, Albert Wesley.—Elected an Associate Member, 267.

Gay, Howard Spooner.—Elected an Associate Member, 531.

Gay, Martin.—Discussion by, 2.

Gaylord, Clifford Willard.—Elected a Junior, 447.

Gaynor, Keyes Christopher. —Elected a Junior, 271.

Gehler, Gustav Willy.—Elected a Member, 161.

Gehring, Herbert August.—Elected an Associate Member, 214.

Gester, William Burr.—Elected a Member, 446.

Gibson, James Edwin.—Elected a Member, 396.

Gideon, Abraham.—Transferred to Grade of Member, 490.

Gilkison, Gordon Mercer.—Elected a Junior, 489.

Gill, Harold Earle.—Elected a Junior, 489.

Gillespie, Chester Gordon.—Elected a Junior, 397.

Gilmore, Alvin Leroy.—Transferred to Grade of Associate, 448.

Glander, John Henry, Jr.—Elected a Junior, 215.

Goad, Charles Edward.—Death announced, 398.

Godfrey, Edward.—Paper by, 159; Discussion by, 530.

Goethals, George Washington.—Elected a Member, 121.

Goldsmith, Clarence.—Elected an Associate Member, 531.

Gómez, Pastor.—Elected a Junior, 122.

Goodman, Leon.—Elected an Associate Member, 271.

Goodrich, E. P.—Discussion by, 159, 265, 530.

Gordon, Samuel.—Elected a Junior, 447.

Gorton, Willard Livermore. —Elected an Associate Member, 214.

Gove, William Granville.—Transferred to Grade of Member, 53.

Graham, Guy Alexander.—Elected a Junior, 397.

Graham, John William.—Elected a Junior, 447.

Grannis, James Kidwell.—Elected a Junior, 397.

Grant, Joseph Alexander.—Elected an Associate Member, 267.

Grant, William.—Elected a Member, 52.

Graves, Walter Joseph. — Transferred to Grade of Member, 4.

Gray, Edward.—Transferred to Grade of Member, 532.

Gray, Harold Farnsworth.—Elected a Junior, 3.

Gray, Harry Woy.—Elected an Associate Member, 488.

Green, F. M.—Paper by, 445.

Green, Theodore.—Elected an Associate Member, 121.

Greenfield, Robert Arthur.—Elected a Member, 446.

Gregory, C. E.—Discussion by, 265.

Gregory, John H.—Paper by, 121.

Greiner, J. E.—On Nominating Committee, 50, 58.

Griggs, Julian.—Discussion by, 121.

Grimm, C. R.—Paper by, 488.

Griswold, Lee Swaney.—Elected an Associate Member, 531.

Groat, Benjamin Feland.—Elected an Associate Member, 214.

Gugerty, E. J.—Resignation accepted, 4.

Gunther, Charles Otto.—Elected an Associate, 397.

Hadley, Homer More.—Elected a Junior, 162.

Hague, William.—Elected an Associate Member, 447.

Haines, Eugene Grove.—Transferred to Grade of Member, 162.

Hale, Richard King.—Transferred to Grade of Associate Member, 54.

Hall, Charles Lacey.—Elected a Junior, 271.

Hall, Hubert Harry.—Transferred to Grade of Associate Member, 216.

Hall, Joseph Emmett.—Elected a Junior, 271.

Hall, Robert Elliot.—Transferred to Grade of Associate Member, 272.

Hall, Warren Esterly.—Transferred to Grade of Associate Member, 272.
Hall, William Henry.—Elected an Associate Member, 447.
Halsey, Milo Clinton.—Elected a Junior, 271.
Hamill, William Samuel.—Elected an Associate Member, 121.
Hamilton, Frank Henry.—Elected a Member, 270.
Hammatt, W. C.—Discussion by, 529.
Hammel, Edward Frederic.—Elected a Junior, 53.
Hammond, Charles Lincoln.—Elected a Member, 214.
Hanavan, William Lawrence.—Transferred to Grade of Associate Member, 532.
Hancock, Henry Sydney, Jr.—Transferred to Grade of Associate Member, 163.
Hanley, William Scott.—Elected an Associate Member, 488.
Hannah, Manton.—Elected a Junior, 489.
Hansen, Andrew Christian.—Elected a Member, 446.
Harding, Harry Spear.—Elected a Junior, 267.
Harding, Henry.—Death announced, 490.
Harrington, Arthur William.—Elected a Junior, 531.
Harris, Archie Lee.—Elected an Associate Member, 267.
Harris, Charles Marshall.—Death announced, 2.
Harris, Frederic Robert.—Elected a Member, 270.
Harris, George Henry.—Elected an Associate Member, 214.
Harrison, Charles L.—On Publication Committee, 55.
Harrod, Tom Hind Hudson.—Elected a Junior, 53.
Hart, R. A.—Discussion by, 119.
Harting, Otto Frederick.—Elected an Associate Member, 161.
Hartman, Russell Theodore.—Transferred to Grade of Member, 490.
Hartmann, Ernest Frederick.—Elected an Associate, 3.
Harts, William W.—Discussion by, 529.
Hartung, Paul August.—Elected an Associate Member, 396.
Harvey, Clarke Kennerley.—Elected an Associate Member, 215.
Harwood, Thomas Triplett Hunter.—Elected a Member, 161.
Hasbrouck, Charles Alfred.—Death announced, 163.
Haselwood, Fred Willis.—Transferred to Grade of Associate Member, 398.
Hastings, Edgar Morton.—Elected an Associate Member, 271.
Hastings, Frank Arnold.—Transferred to Grade of Member, 268.
Havens, William Westerfield.—Elected a Junior, 531.
Hawkesworth, John.—Paper by, 119.
Hawley, Charles Ray.—Transferred to Grade of Associate Member, 163.
Hayes, Andrew Jenkins.—Elected an Associate Member, 396.
Hayes, Charles Edward.—Transferred to Grade of Associate Member, 268.
Haynes, Claude Sanford.—Elected an Associate Member, 3.
Hays, David Walker.—Elected an Associate Member, 267.
Hays, Donald Symington.—Elected an Associate Member, 447.
Hayt, Robert Olcott.—Transferred to Grade of Member, 272.
Hazen, Allen.—Discussion by, 121, 160.
Healey, Charles Frank.—Elected an Associate Member, 271.
Healey, John Paul.—Elected an Associate Member, 531.
Heiser, Alfred Brackenridge.—Elected a Junior, 489.
Heiser, William Joseph.—Elected a Junior, 489.
Henderson, John Taylor.—Elected a Junior, 489.
Hendricks, Kearney Everett.—Elected an Associate Member, 447.
Henes, Harry William.—Elected a Junior, 267.
Henry, George Jackson, Jr.—Elected a Member, 161.

HERING, RUDOLPH.—Discussion by, 119.

HERSCHEL, CLEMENS.—Discussion by, 530.

HEWETT, B. H. M., and W. L. BROWN. —Paper by, 266.

HEWIT, BENJAMIN HARTLEY.—Elected a Junior, 215.

HICKOK, CLIFTON EWING.—Elected a Junior, 531.

HIDINGER, LEROY LEMAYNE.—Elected an Associate Member, 447.

HIGGINS, CHARLES H.—Discussion by, 52.

HILL, JOHN J.—Elected an Associate Member, 161.

HILTS, HAROLD EZRA.—Elected an Associate Member, 267.

HIRSCH, JOHN GEORGE.—Elected a Junior, 271.

HODGMAN, HARRY.—Transferred to Grade of Member, 268.

HOLBROOK, WINFIELD.—Transferred to Grade of Associate Member, 448.

HOLLOWAY, ROGER TIFFT.—Elected a Junior, 267.

HOLMES, LEMUEL.—Elected a Member, 121.

HOLMES, THOMAS HUGHES.—Elected a Junior, 3.

HOLT, ARTHUR GRANT.—Elected a Member, 161.

HOLTZMAN, STEPHEN FORD.—Transferred to Grade of Member, 490.

HOOD, HUGH KENDALL.—Elected an Associate Member, 52.

HOOD, JAMES HENRY.—Elected an Associate Member, 162.

HOOD, JOHN MIFFLIN, JR.—Transferred to Grade of Member, 397.

HOOVER, C. B.—Discussion by, 121.

HOOVER, HERBERT CLARK.—Elected a Member, 2.

HOPKINS, NEWTON FISHER.—Transferred to Grade of Member, 448.

HOPSON, E. G.—Paper by, 446.

HORAN, JOHN JOSEPH.—Death announced, 120.

HORTON, ROBERT ELMER.—Transferred to Grade of Member, 268.

HOSMER, RALPH HERBERT.—Elected an Associate Member, 531.

HOUGH, D. L.—Discussion by, 51.

HOW, RICHARD WILLIS.—Transferred to Grade of Member, 272.

HOWARD, EDWARD HENRY.—Elected a Member, 266.

HOWE, CLARENCE DURAND.—Elected an Associate Member, 52.

HOWE, HARRY NORTHROP.—Transferred to Grade of Associate Member, 163.

HOWE, HORACE J.—Paper by, 2; Appointed Teller to Canvass Ballot for Officers, 49, 57.

HOWE, WALTER CLARK.—Elected an Associate Member, 267.

HOWIE, HOWARD BENSON WILBERFORCE.—Transferred to Grade of Associate Member, 532.

HOYT, WARREN ALBERT.—Elected a Member, 270.

HUBBARD, DANIEL.—Elected a Junior, 531.

HUBBARD, ISAAC WENDELL.—Transferred to Grade of Member, 4.

HUBER, WALTER LEROY.—Transferred to Grade of Associate Member, 123.

HUDSON, DARWIN SHAW.—Elected an Associate Member, 162.

HUDSON, H. W.—Presents paper, 445.

HUFSCHMIDT, WILLIAM PAUL. — Elected an Associate Member, 447.

HUGHES, JOHN WILBUR.—Elected a Member, 270.

HUGHES, NORMAN.—Elected a Junior, 531.

HUMPHREY, HENRY CYPRIAN.—Death announced, 120.

HUMPHREY, R. L.—Discussion by, 119.

HUMPHREYS, CLIFTON STEWART.—Transferred to Grade of Member, 163.

HUNT, CHARLES WARREN.—Elected Secretary, 55; On Library Committee, 55; On Committee of Arrangements for Annual Convention, 165; On Committee on the Licensing of Civil Engineers, 171.

HUNTER, JOSEPH WRAY.—Elected a Member, 214.

HUTCHINS, EDWARD.—Transferred to Grade of Associate Member, 4.

HUTCHINS, HARRY CROCKER.—Elected a Junior, 122.

HUTCHINS, ROLAND ELLIS.—Elected a Junior, 489.

"Hydrography as an Aid to the Successful Operation of an Irrigation System," presented and discussed, 530.

Irish, Leland Wesley.—Transferred to Grade of Associate Member, 54.

Irvin, Charles Richard.—Elected a Junior, 397.

Irwin, Roger Brooke.—Elected an Associate Member, 215; Death announced, 398.

Ives, Howard Chapin.—Transferred to Grade of Associate Member, 163.

Iyer, Ramaswamier Panchanadam.—Elected an Associate, 447.

Jackson, William. — Death announced, 398.

Jacobsen, Hans Petter Rude. — Elected a Member, 214.

Jacobson, Alfred Leon.—Elected an Associate Member, 162.

James, Merton Earle.—Elected an Associate Member, 447.

Japp, Henry.—Paper by, 1; Discussion by, 2.

Jaques, Jacob Duncan.—Elected an Associate Member, 488.

Jaudon, Henry Scudder.—Transferred to Grade of Member, 53.

Jenckes, Lawrence Bates.—Transferred to Grade of Member, 397.

Jervey, James Postell.—Elected a Member, 488.

Jewel, Lindsey Louin.—Transferred to Grade of Member, 490.

Jewett, John Young.—Elected an Associate Member, 396.

Johnson, Luther Elman.—Death announced, 265.

Johnson, Natt Madison.—Elected an Associate Member, 447.

Johnson, Robert Chan.—Elected an Associate Member, 52.

Jones, Jonathan.—Elected an Associate Member, 396.

Jones, Ralph Henry.—Elected a Junior, 3.

Jones, Robert Sharp.—Elected an Associate Member, 271.

Jones, Washington.—Death announced, 398.

Jordan, Myron Kendall.—Elected a Junior, 122.

Jordán, Ricardo Tomás.—Elected a Member, 446.

Kanary, Mark Henry.—Elected an Associate Member, 215.

Karnopp, Edwin Benjamin.—Transferred to Grade of Associate Member, 448.

Kays, Marion Reed.—Elected an Associate Member, 531.

Keator, Edward Orris.—Elected an Associate Member, 267.

Kempkey, Augustus, Jr.—Transferred to Grade of Associate Member, 54; Paper by, 159.

Kenyon, William John Charles.—Elected an Associate, 267.

Kesner, Henry James.—Elected a Junior, 531.

Kimball, George A.—Elected Director, 51, 77; On Finance Committee, 55.

Kimball, Herbert Sawyer.—Elected a Member, 488.

King, Roy Stevenson.—Elected an Associate Member, 3.

Kinney, Edward Cornelius.—Death announced, 54.

Kinney, William Morton.—Elected a Junior, 397.

Kinsey, William Ambrose.—Elected an Associate Member, 267.

Kittredge, Frank Alvah.—Elected a Junior, 122.

Kittredge, George W.—On Library Committee, 55.

Kittredge, Harry Chandler. — Elected an Associate Member, 121.

Knap, Joseph M.—Elected Treasurer, 51, 77; Nominated as Treasurer, 450.

Knight, Herbert Miller.—Elected a Member, 214.

Koch, John Christian.—Elected an Associate Member, 3.

Koon, Joseph Burr.—Elected an Associate Member, 215.

Krone, Arnold Henry.—Elected an Associate Member, 267.

Kuichling, E.—Discussion by, 121.

Kyle, Ralph Briggs.—Elected an Associate Member, 215.

Lamb, William Alfred.—Transferred to Grade of Associate Member, 216.

LANAGAN, FRANK RAY.—Transferred to Grade of Associate Member, 54.

LAND, JOHN THOMAS.—Elected an Associate Member, 447.

LANE, HARRY ALFRED.—Transferred to Grade of Member, 122.

LANG, FRANK AUGUST.—Elected an Associate Member, 121.

LANT, FRANK PARSONS.—Transferred to Grade of Member, 53.

LARKINS, EDGAR ERNEST.—Elected an Associate Member, 396.

LARUE, EUGENE CLYDE.—Elected an Associate Member, 3.

LAVIS, F.—Paper by, 161; Discussion by, 487.

LAW, WALTER HILLS.—Elected an Associate Member, 267.

LAWTON, RICHARD MACK.—Elected an Associate Member, 215.

LAYFIELD, E. M.—On Committee of Arrangements for Annual Convention, 165.

LAYNG, FRANK RAHN SHUNK.—Transferred to Grade of Associate Member, 216.

LEACH, THOMAS.—Elected a Junior, 271.

LEARNED, ALBERT PREISACH.—Elected a Junior, 531.

LEE, DAVID READ.—Transferred to Grade of Member, 490.

LEE, FRANCIS VALENTINE TOLDERVY.—Elected a Member, 52.

LEFFLER, BURTON RUTHERFORD.—Transferred to Grade of Member, 397.

LEH, ELVIN ULYSSES.—Elected a Member, 266.

LELAND, ORA MINER.—Transferred to Grade of Member, 122.

LEONARD, CLIFFORD MILTON.—Transferred to Grade of Member, 268.

LEONARD, EDWARD PHILIP.—Elected a Junior, 215.

LETTON, HARRY PIKE.—Elected a Junior, 53.

LEWIS, WILLIAM WILLETT.—Elected a Member, 161.

Library.—Accessions to the, 21, 96, 129, 177, 222, 231, 406, 456, 498, 541.

Library Committee.—Appointment of, 55.

LINCOLN, EDWARD LEWIS.—Elected a Junior, 215.

LINDAU, A. E.—Discussion by, 530.

LIVINGSTON, JULIUS I.—Death announced, 163.

Local Associations of Members of the American Society of Civil Engineers.—Abstract of Minutes of Meetings of, 10, 95, 128, 174, 219, 317, 318, 402, 403, 454, 495, 538.

LOCKWOOD, RICHARD JOHN.—Elected an Associate Member, 215.

LOCKWOOD, WILLIAM FREDERICK.—Elected a Member, 446.

LOE, ERIC HALDORSON.—Elected a Member, 52.

LOOMIS, HORACE.—Elected Director, 51, 77; On Finance Committee, 55.

LORD, HAROLD.—Death announced, 530.

LORENZ, GEORGE BENJAMIN.—Elected an Associate Member, 3.

LOWETH, CHARLES F.—Elected Director, 51, 77; On Committee of Arrangements for Annual Convention, 165.

LOWINSON, O.—Discussion by, 51, 52.

LUDLOW, JUSTIN WYMAN.—Transferred to Grade of Associate Member, 123.

LUEDER, ARCHIBALD BYRON.—Elected a Member, 266.

LUSH, CUYLER WARFIELD.—Transferred to Grade of Associate Member, 268.

LYERLY, CHARLES ABNER, JR.—Elected a Junior, 53.

LYNCH, ALEXANDER SYDNEY.—Elected a Junior, 531.

MACCALLA, CLIFFORD SHERRON.—Elected a Member, 121.

MACDIARMID, MILO STUART.—Transferred to Grade of Member, 163.

MACFARLANE, ARTHUR KEDDIE.—Death announced, 530.

MACGREGOR, ROBERT ATHOLE.—Transferred to Grade of Member, 122; Discussion by, 487.

MACHARG, WILLIAM STORRS.—Death announced, 265.

MACK, GEORGE HORACE.—Elected a Junior, 397.

MACVICAR, JOHN DUNCAN.—Elected a Member, 266.

MCBEE, VARDRY ECHOLS, JR.—Death announced, 398.

McCausland, Charles Patterson.—Elected as Associate Member, 531.
McClintock, James Robinson. — Transferred to Grade of Associate Member, 216.
McClure, Harry Clifford.—Elected a Junior, 122.
McClure, Hunter.—Elected a Junior, 3.
McConaghy, Robert Allen.—Elected a Member, 52.
McCullough, Ernest.—Elected a Member, 266.
McDaniel, Allen Boyer.—Transferred to Grade of Member, 532.
McDonald, Hunter.—Elected Vice-President, 51, 77; On Library Committee, 55.
McDonough, James Albert.—Transferred to Grade of Member, 215.
McDowell, R. F.—Discussion by, 121.
McElroy, Fred Woodburn.—Elected a Member, 396.
McFarland, Walter Ashfield.—Elected a Member, 214.
McKay, John Edwards.—Death announced, 268.
McLachlan, Duncan William.—Elected an Associate Member, 531.
McLean, Joseph P.—Discussion by, 160.
McLoud, Paul.—Elected a Member, 396.
McLoughlin, Joseph Navarre. — Elected an Associate Member, 488.
McLure, Norman R.—Discussion by, 52.
McMenimen, William Vincent.—Transferred to Grade of Associate Member, 268.
McMullen, Ray Webb.—Elected a Junior, 271.
McNary, Joseph Vance.—Elected an Associate Member, 271.
McNeil, Arthur James. — Transferred to Grade of Associate Member, 123.
McVean, John Jay.—Death announced, 398.
McWethy, LeRoy.—Elected a Junior, 3.
Maglott, George Frederick.—Elected a Junior, 447.
Magruder, Frank Cecil. — Transferred to Grade of Associate Member, 448.
Maguire, Joseph T.—Discussion by, 530.
Mahon, Ross LeHunt.—Elected an Associate Member, 52.
Mahone, William, Jr.—Elected a Junior, 162.
Malmros, Nils Lorentz.—Elected a Member, 52.
Manchester, Ernest James Theodore.—Transferred to Grade of Member, 448.
Manzanilla y Carbonell, José Justo.—Elected a Junior, 271.
Marden, Henry Herman, Jr.—Death announced, 398.
Marsh, Charles Reed.—Elected a Junior, 271.
Marshall, Urban Serenus.—Elected an Associate Member, 53.
Marston, Frank Alwyn.—Elected a Junior, 122.
Martin, Franklin William.—Transferred to Grade of Associate Member, 54.
Martin, James William.—Transferred to Grade of Member, 163.
Martin, John.—Elected an Associate Member, 267.
Martin, Richard Herbert.—Elected an Associate Member, 447.
Mason, Francis, James H. Brace, and S. H. Woodard.—Paper by, 1.
Mason, William Pitt.—Elected a Member, 52.
Maughmer, Carl.—Elected an Associate Member, 3.
Maurice, George Holbrooke. — Elected a Member, 2.
Maxwell, Donald Hebard.—Elected a Junior, 162.
Mayne, Charles.—Resignation accepted, 4.
Meads, Charles.—Elected a Member, 396.
Means, Howard Chester.—Elected an Associate Member, 271.
Means, Thomas H.—Discussion by, 119.
Mears, Frederick.—Elected an Associate Member, 53.
Meem, James C.—On Nominating Committee, 50, 58; Discussion by, 51; Paper by, 265.

MEEM, JAMES LAWRENCE.—Elected an Associate Member, 447.
MEEM, STEPHEN HALSEY.—Elected a Member, 52.
MEIER, WILLIAM.—Death announced, 123.
Membership.—Additions, 26, 99, 133, 182, 226, 330, 409, 461, 503, 545; Changes of Address, 137, 186, 230, 340, 412, 465, 506; Resignations, 29, 191, 418, 470; Deaths, 30, 101, 140, 192, 236, 350, 418, 470, 510, 548.
MENKE, WILLIAM.—Elected a Junior, 531.
MENSCH, L. J.—Discussion by, 159.
MERCER, C. D.—Resignation accepted, 4.
MERRILL, FARRAND SEYMOUR.—Elected an Associate Member, 162.
MERRILL, OGDEN.—Discussion by, 51.
MERRIMAN, THADDEUS.—Transferred to Grade of Member, 532.
MERRITT, CHARLES EDWARD.—Elected a Junior, 3.
MESSER, HOPE RICHARD.—Elected a Junior, 447.
METCALF, WILLIAM. — Death announced, 2.
Metric System in the United States, Committee on Status of.—Final Report of, 50, 69.
METZGER, LOUIS CHARLES FREDERICK. —Elected an Associate Member, 267.
Mexico.—Request for Recognition of Corporate Membership in the Society in, 164.
MILLER, MAX M.—Discussion by, 488.
MILLER, WALTER EDWARD.—Elected an Associate Member, 267.
MINOR, CYRUS EDWARD.—Elected an Associate Member, 267.
Minutes of Meetings of the Board of Direction, 5, 55, 56, 123, 164, 216, 273, 399, 448, 490, 533.
Minutes of Meetings of the Society, 1, 2, 49, 51, 119, 120, 159, 160, 213, 265, 266, 395, 445, 446, 487, 448, 529, 530, 532.
MITCHELL, LOUIS ADOLPH.—Elected an Associate Member, 267.
MOISSEIFF, LEON S.—Discussion by, 488.
MOLITOR, D. A.—Presents Report of Special Committee on the Status of the Metric System, 50, 69.
MONTFORT, RICHARD.—On Nominating Committee, 50, 59.
Monthly List of Recent Engineering Articles of Interest, 31, 102, 142, 193, 237, 352, 419, 471, 511, 549.
MOORE, EGBERT JESSUP.—Transferred to Grade of Member, 268.
MOORE, LEWIS EUGENE.—Transferred to Grade of Associate Member, 163.
MOORE, WALTER SMYTH.—Elected a Junior, 531.
MOORSHEAD, OLIVER.—Elected an Associate Member, 267.
MOORSHEAD, THOMAS COURTNEY.—Transferred to Grade of Member, 272.
MORGAN, ARTHUR ERNEST.—Elected an Associate Member, 215.
MORITZ, ERNEST ANTHONY.—Transferred to Grade of Associate Member, 4.
MORRILL, ASA HALL.—Elected a Member, 214.
MORRIS, MARSHALL, JR.—Elected a Member, 52.
MORRISON, GEORGE ELDRIDGE.—Elected an Associate Member, 489.
MORSE, GEORGE F.—Discussion by, 119.
MORSE, ROBERT BROOKS.—Elected an Associate Member, 271.
MORSE, WALTER LEVI.—Elected a Member, 214.
MOSLEY, EARL LOUIS.—Elected an Associate Member, 396.
MOTT, THOMAS CLAYTON.—Elected a Junior, 215.
MUCHEMORE, HARRIE LANGDON. — Elected a Junior, 122.
MULLER, LESLIE.—Elected an Associate Member, 53.
MUNKELT, FREDERICK HERMANN.—Elected a Junior, 162.
MUNSON, JOHN GEPHART.—Elected an Associate Member, 396.
MURPHY, JAMES FRANCIS.—Elected a Junior, 267.
MURRAY, JOHN BONAVENTURE. — Elected an Associate Member, 396.
MYERS, GEORGE HIGGINS.—Death announced, 530.

NAGEL, ROBERT.—Elected an Associate Member, 271.

Nagel, Theodore.—Elected a Junior, 531.
Navarrete, Salvador Maria. — Elected an Associate Member, 121.
Neely, John Thompson.—Elected an Associate Member, 531.
Nelson, Archy Magill.—Elected a Member, 446.
Newell, Robert J.—Elected an Associate Member, 53.
Newton, John Parsons.—Elected an Associate Member, 215.
"Nickel Steel for Bridges," awarded the Norman Medal, 52, 55.
Nicol, Walter Hilliard.—Elected an Associate Member, 271.
Nicolaysen, Albin Georg.—Transferred to Grade of Associate Member, 448.
Nikolitch, Milan.—Transferred to Grade of Associate Member, 163.
Noble, Alfred.—Presides at Meeting, 1; Presents Minority Report of Special Committee on Uniform Tests of Cement, 67; Discussion by, 161; Lecture by, 270.
Noble, Frederick Charles.—Transferred to Grade of Member, 122.
Nolan, Simon Frank.—Elected an Associate Member, 162.
Nolen, William Isaac.—Elected an Associate Member, 215.
Nominations, Committee on.—Appointment of, 50, 57; Presents List of Nominees, 450.
Norman Medal.—Award of, 52, 55.
"Notes on the Replacing of the Superstructure of the Harlem Ship Canal Bridge," presented and discussed, 2.
Nugent, Paul Cook.—Elected a Member, 214.

Oakes, John Calvin.—Transferred to Grade of Member, 268.
O'Brien, Daniel Bernard.—Transferred to Grade of Associate Member, 216.
O'Connell, George Paul.—Elected an Associate Member, 396.
O'Donnell, Charles Jerome. — Elected a Junior, 162.
Ogier, George Rufus.—Elected a Junior, 3.
O'Hara, Joseph Matthew.—Elected an Associate Member, 271.
Okes, Day Ira.—Elected a Junior, 122.
O'Neil, Harry Bernard.—Elected a Junior, 489.
O'Neil, Joseph.—Elected an Associate Member, 53.
Opdycke, H. G.—Discussion by, 51.
O'Reilly, Francis Sheridan. — Elected a Junior, 3.
Orr, John.—Elected a Member, 446.
Ostrup, J. C.—Discussion by, 159, 160.
Overocker, Daniel Willets. — Elected a Junior, 447.
Owen, James.—Presides at Meeting, 120, 213; On Committee on the Licensing of Civil Engineers, 171.

Paget, Charles Sounders.—Elected an Associate Member, 489.
Palm, Thomas Jefferson.—Elected an Associate Member, 447.
Paret, John Waldo.—Elected a Junior, 53.
Parker, A. McC.—Resignation accepted, 4.
Parker, James Lafayette.—Transferred to Grade of Associate Member, 216.
Parlin, Raymond Washington. — Elected a Junior, 271.
Parrigin, Frank Snow.—Elected a Junior, 215.
Parsons, Augustus Taber.—Transferred to Grade of Associate Member, 448.
Parsons, Harold Ashton.—Transferred to Grade of Member, 532.
Parthesius, Philip Henry.—Elected an Associate Member, 489.
Patten, William Nickels.—Elected a Member, 270.
Patterson, Irving Wooster.—Elected a Junior, 3.
Paul, Theodore Lochart.—Elected a Junior, 53.
Payne, William Arthur.—Elected a Member, 52; Discussion by, 160.
Peabody, Alonzo Orrin.—Elected a Junior, 271.
Peabody, Lionel Henry, Jr.—Transferred to Grade of Associate Member, 4.
Peck, Ermon Miland.—Elected an Associate Member, 162.

Peck, John Gates.—Transferred to Grade of Member, 490.
Peden, Leo Thomas.—Elected an Associate Member, 267.
Pegram, George H.—Presides at Meeting, 2, 119, 213, 395; On Finance Committee, 55.
Pendlebury, Edward.—Transferred to Grade of Associate Member, 162.
Perrine, Ren Brown.—Elected a Member, 266.
Perry, Francis W.—Discussion by, 265.
Peters, Frederic Hatheway. — Elected an Associate Member, 271.
Peters, John Marvin.—Transferred to Grade of Associate Member, 490.
Pfau, Julius Welch.—Transferred to Grade of Member, 532.
Philbrook, Lee Elmo.—Elected an Associate Member, 215.
Phillips, Frederick Clinton.—Transferred to Grade of Member, 448.
Pires do Rio, Jose.—Elected an Associate Member, 3.
Pitts, Thomas Dorsey.—Transferred to Grade of Member, 448.
Plummer, Horace Edwards.—Transferred to Grade of Associate Member, 54.
Polk, Martin Collins.—Elected an Associate Member, 489.
Polleys, W. V.—Discussion by, 52.
Poole, Ruble Isaac.—Elected a Junior, 531.
Porter, Harry F.—Discussion by, 159.
Poss, Victor Henry.—Elected a Member, 161.
Potter, Alexander.—Discussion by, 121.
Potts, Clyde.—Transferred to Grade of Member, 272.
Powell, Maurice Vernon.—Elected an Associate Member, 447.
"Precarious Expedients in Engineering Practice," presented and discussed, 119.
"Pressure, Resistance, and Stability of Earth," presented and discussed, 265.
Preston, Charles Henry, Jr.—Transferred to Grade of Member, 398.
Price, Donald Douglas.—Elected a Junior, 397.
Price, William Edmund.—Elected a Junior, 162.
Pritchard, John Charles.—Transferred to Grade of Associate Member, 448.
Pritchett, Charles Marcellus.—Transferred to Grade of Member, 4.
Prizes, Committee to Recommend the Award of.—Report of, 52, 55.
Probasco, Samuel R.—Death announced, 54.
Proctor, Asa Glisson.—Elected a Junior, 447.
Publication Committee.—Appointment of, 55.
Purdy, Samuel Moreau.—Elected a Member, 214; Discussion by, 487, 529.

Quick, Alfred Merritt.—Transferred to Grade of Member, 215.
Quimby, Charles Henry, Jr.—Transferred to Grade of Member, 272.
Quimby, John Herman.—Elected an Associate Member, 162.

Raider, Harry Adam.—Elected an Associate Member, 489.
Rail Sections, Committee on.—Progress Report of, 50, 62; Final Report of, 269, 291.
Raldiris, J. L.—Telegram from, Relative to Bill for Licensing of Civil Engineers, 160.
Ramser, Charles Ernest.—Elected a Junior, 122.
Randolph, Isham.—On Nominating Committee, 50, 59.
Randolph, Richard Wood.—Elected an Associate Member, 531.
Randolph, Robert Isham.—Transferred to Grade of Associate Member, 490.
Randorf, Charles Andrew.—Elected an Associate Member, 531.
Ranney, Charles Garfield.—Transferred to Grade of Associate Member, 54.
Rapalje, Herbert DeWitt.—Elected an Associate Member, 396.

RASTER, WALTHER.—Transferred to Grade of Member, 532.

RATCLIFF, W. H., JR.—Resignation accepted, 4.

RAY, DAVID HEYDORN.—Transferred to Grade of Associate, 123.

RAYMER, ALBERT REESOR.—Elected a Member, 121.

RAYMOND, ALFRED.—Elected a Member, 396.

REED, WILLIAM B.—Discussion by, 161.

REESE, GEORGE WASHINGTON.—Elected a Junior, 268.

REEVES, HARLEY EDSON.—Elected a Member, 2.

"Remedies for Landslides and Slips on the Kanawha and Michigan Railway," presented and discussed, 395.

Report of Board of Direction, 11, 49, 57.

Report of Board of Direction Relative to the Appointment of Proposed Committee on Preservation of Wood, 269, 273, 282; Discussion on, 283.

Report of Committee on Bituminous Materials for Road Construction, 50, 62, 569.

Report of Committee on Concrete and Reinforced Concrete, 51, 76.

Report of Committee on Engineering Education, 50, 65.

Report of Committee on Steel Columns and Struts, 50, 59; Discussion on, 60.

Report of Committee on the Licensing of Civil Engineers, 269, 299; Discussion on, 303.

Report of Committee on the Status of the Metric System in the United States, 50, 69.

Report of Committee to Recommend the Award of Prizes, 52, 55.

Report of Secretary, 18, 49, 57.

Report of Secretary Relative to Time and Place for Holding Forty-third Annual Convention, 269, 287.

Report of Tellers Appointed to Canvass Ballot for Officers, 51, 77.

Report of Treasurer, 20, 49, 57.

Reports of Committee on Rail Sections, 50, 62, 269, 291.

Reports of Committee on Uniform Tests of Cement, 50, 66.

Resolution of the Board of Direction Relative to Proposed Legislation on the Licensing of Civil Engineers, 160, 164, 171.

Resolution of the Board of Direction Relative to Status of Civil Engineers in Engineer Corps of United States Army, 123.

Resolution Relative to the Appointment of a Committee on the Licensing of Civil Engineers, 161.

Resolution Relative to the Appointment of a Committee on the Preservation of Wood, 121.

REYNOLDS, LEON BENEDICT.—Elected a Junior, 447.

RHETT, ALBERT HASKELL.—Elected an Associate Member, 396.

RHETT, EDMUND MOORE.—Transferred to Grade of Member, 448.

RHINES, GEORGE VOLNEY.—Transferred to Grade of Member, 53.

RHODES, CLAUDE IRVIN.—Transferred to Grade of Associate Member, 123.

RHODES, GLENN VERNON.—Elected a Junior, 215.

RHYS-ROBERTS, EDMUND ALYTH.—Death announced, 2.

RICE, GUY WICKLIFFE.—Elected an Associate Member, 215.

RICE, JOHN MARIE THOMAS.—Transferred to Grade of Associate Member, 532.

RICH, JOHN ROBERT.—Elected an Associate Member, 531.

RICH, MELVIN S.—Transferred to Grade of Associate Member, 268.

RICHARDS, ARTHUR.—Elected a Junior, 3.

RICHARDSON, CLINTON LEROY.—Death announced, 398.

RICHARDSON, JOSHUA WILSON.—Elected a Member, 530.

RICHMOND, JACKSON LETTON.—Elected an Associate Member, 447.

RIGHTER, ADDISON ALEXANDER.—Elected a Member, 2.

RIGHTOR, FRED ELMER.—Elected an Associate Member, 267.

RIGHTS, HERBERT TIMOTHY.—Elected an Associate Member, 162.

RITCHEY, JESSE STEELE.—Elected a Junior, 3.

RITTER, ROLLIN.—Elected an Associate Member, 267.

ROACH, JAMES HOWARD.—Elected an Associate Member, 162.

Road Construction, Committee on Bituminous Materials for.—Progress Report of, 50, 62, 569.

ROBERG, RALPH MASON.—Elected a Junior, 397.

ROBERTS, PERCIVAL, JR.—Elected Director, 51, 77.

ROBERTS, RICHARD FRANCIS.—Elected a Junior, 268.

ROBERTSON, F. E.—Discussion by, 119.

ROBINSON, ERNEST FRANKLIN.—Transferred to Grade of Associate Member, 448.

ROBINSON, GEORGE LOOMIS.—Transferred to Grade of Member, 532.

ROBINSON, JOHN MASON.—Elected a Member, 488.

ROBINSON, STILLMAN WILLIAMS.—Death, announced, 529.

ROBINSON, WILLIAM HARPER.—Elected a Member, 121.

ROGERS, AUGUSTUS WEBSTER.—Elected an Associate Member, 489.

ROLLINS, CHARLES WORD.—Elected a Member, 161.

ROME, LYFORD.—Elected a Junior, 489.

ROSENBERG, THEODORE.—Elected a Member, 2.

ROSTOCK, JOHN HENRY.—Elected a Member, 214.

ROWE, SAMUEL MCMATH.—Death announced, 398.

ROWELL, GEORGE FREEMAN.—Transferred to Grade of Member, 4.

Rowland Prize.—Award of, 52, 55.

ROWNTREE, BERNARD.—Elected an Associate, 162.

RUGGLES, C. A.—Discussion by, 52.

RUNDLETT, LEONARD W.—Nominated as Director, 450.

RUSSELL, S. BENT.—Discussion by, 159.

"Rust, as Shown in the Removal of a Seventeen-Story Building," presented and discussed, 487.

RYAN, WALTER J.—Transferred to Grade of Associate Member, 123.

ST. JOHN, WALTER SHERMAN.—Elected a Junior, 397.

St. Louis, Mo., Members of the American Society of Civil Engineers. —Letter from, 50, 74.

SALAS, RAFAEL ALVAREZ.—Elected a Member, 2.

SAMPLE, JOHN HENDERSON.—Death announced, 265.

SAMUEL, GEORGE FREDERICK.—Elected a Member, 396.

SANBORN, MORTON FRANKLIN.—Elected an Associate Member, 121.

SANFORD, GEORGE OTIS.—Transferred to Grade of Member, 4.

San Francisco Association of Members of the American Society of Civil Engineers.—Amendment to Constitution Relative to Annual Meeting Approved, 56; Abstract of Minutes of Meetings of, 174, 402, 403, 495.

SAUCEDO, VICENTE.—Transferred to Grade of Associate Member, 216.

SAUNDERS, HENRY JENNESS.—Elected an Associate Member, 215.

SAUNDERS, WALTER BOWEN.—Elected an Associate Member, 3.

SAWYER, PERCY.—Transferred to Grade of Associate Member, 4.

SCHERMERHORN, HARVEY OBED.—Elected an Associate Member, 121.

SCHICK, JAMES REESE.—Elected a Member, 121.

SCHRADER, FREDERICK ADOLPH.—Elected an Associate Member, 3.

SCHREIBER, HERMAN VICTOR.—Elected an Associate Member, 121.

SCHULZ, WALTER FREDERICK.—Elected a Member, 446.

SCHUYLER, PHILIP.—Elected an Associate Member, 267.

SCOTT, JAMES ROBINSON, JR.—Elected a Junior, 122.

SCOTT, JOHN KUHN.—Transferred to Grade of Associate Member, 532.

SCOTT, R. D.—Discussion by, 121.

SCOTT, WILLIAM FRY.—Paper by, 530; Discussion by, 530.

SEABURY, ARTHUR G.—Resignation accepted, 4.

SEARIGHT, GEORGE PETER.—Elected a Junior, 489.

SEARS, WALTON HARVEY.—Elected an Associate Member, 162.

SEAVER, CLIFFORD.—Elected an Associate Member, 531.

Secretary.—Report of, 18, 49, 57; Election of, 55; Statement of, Relative to Action of the Society on Proposed Legislation on the Licensing of Civil Engineers, 160, 171; Report of, Relative to Time and Place for Holding Forty-third Annual Convention, 269, 287.

See, Russell Alva.—Elected a Junior, 447.

Seeley, Henry Arthur.—Elected a Junior, 3.

Shanley, James Roosevelt.—Death announced, 398.

Shapleigh, Charles Henry.—Elected a Junior, 271.

Shaw, George Harry Thornton.—Elected a Member, 446.

Shaw, George Herbert.—Elected an Associate Member, 162.

Shaw, Walter Farnsby.—Elected a Junior, 3.

Shaw, William Thomas.—Elected an Associate Member, 271.

Shearer, Charles English.—Elected an Associate Member, 531.

Sheffield, Edward Newton.—Elected an Associate Member, 162.

Sheley, Horace W.—Discussion by, 446.

Shepherd, Frank Cummings.—Transferred to Grade of Member, 53.

Sherman, Arthur Louis.—Elected a Junior, 3.

Sherman, Edward Clayton.—Transferred to Grade of Member, 53.

Sherman, LeRoy Kempton.—Elected a Member, 396.

Sherrerd, M. R.—Discussion by, 119.

Shipman, C. E.—Discussion by, 530.

Shoecraft, Ezra Collin.—Elected an Associate Member, 396.

Shoemaker, Louis Henry.—Transferred to Grade of Member, 398.

Sieling, Louis John.—Elected a Junior, 53.

Sikes, Zenas Harrison.—Elected an Associate Member, 271.

Silliman, Charles.—Elected a Member, 121.

Slattery, Lawrence Patrick.—Elected an Associate Member, 53.

Slocum, Harry Spencer.—Elected an Associate Member, 489.

Smetters, Samuel Tupper.—Elected a Member, 396.

Smith, Albert Mather.—Death announced, 268.

Smith, Chester Alexander.—Elected an Associate Member, 162.

Smith, Donald David.—Elected an Associate Member, 396.

Smith, Edward Sheppard.—Elected an Associate Member, 531.

Smith, Eliot Nichols.—Transferred to Grade of Associate Member, 272.

Smith, G. E. P.—Discussion by, 214.

Smith, Harradon Sterling.—Transferred to Grade of Member, 163.

Smith, J. Waldo.—Lecture by, 270.

Smith, Karl Garthwaite.—Elected an Associate Member, 215.

Smith, Layton Fontaine.—Transferred to Grade of Member, 163.

Smith, Lewis Ruffner, Jr.—Elected a Junior, 531.

Smith, William Durkee.—Elected a Junior, 447.

Smoley, Constantine Kenneth.—Elected an Associate Member, 271.

Smoyer, Lloyd Isadore.—Elected a Junior, 447.

Snell, Joseph Emmett.—Elected an Associate Member, 162.

Snell, Roy Martin.—Elected an Associate Member, 396.

Snow, Jonathan.—Nominated as Director, 450.

Soest, Hugo Conrad.—Elected a Junior, 268.

"Some Mooted Questions in Reinforced Concrete Design," presented and discussed, 159.

Sommer, Albert.—Elected an Associate, 53.

Soper, Ralph Carroll.—Death announced, 398.

Soule, Edward Lee.—Transferred to Grade of Associate Member, 4.

Spaulding, Ralph Edgar.—Elected a Junior, 268.

Speakman, Richard Edward.—Elected a Member, 2.

Spelman, John Rodgers.—Elected an Associate Member, 531.

Spencer, Frank Norton.—Elected an Associate Member, 271.

Sperry, Austin Russell Willard.—Elected a Junior, 531.

Sprague, Norman Salisbury.—Transferred to Grade of Member, 268.

SPROUL, ARCHIBALD ALEXANDER.—Death announced, 265.
STABLER, HERMAN.—Elected an Associate Member, 489.
STADEL, GEORGE HENRY.—Elected a Junior, 397.
STANLEY, ORRIN ELMORE.—Transferred to Grade of Member, 268.
STANSBURY, HERBERT EARL.—Elected an Associate Member, 215.
STANTON, HARRY SEEL.—Elected a Junior, 447.
STANTON, ROBERT BREWSTER, JR.—Elected a Junior, 122.
STANTON, WILBOR DICKENS.—Transferred to Grade of Associate Member, 216.
STARR, WILLIAM WRIGHT.—Death announced, 54.
Steel Columns and Struts, Committee on.—Progress Report of, 50, 59; Discussion on Progress Report of, 60.
STEINMAN, DAVID BERNARD.—Elected a Junior, 122.
STEPHENSON, JAMES, JR.—Elected a Member, 161.
STERN, E. W.—Discussion by, 119.
STEVENS, HAROLD CONVERSE.—Elected an Associate Member, 271.
STEVENS, J. C.—Paper by, 530.
STICKLE, HORTON WHITEFIELD.—Elected a Member, 446.
STILES, OTHO WILLIAM.—Elected an Associate Member, 531.
STILSON, CHARLES EDWARD.—Elected a Junior, 122.
STOTT, HENRY G.—Discussion by, 213; Nominated as Director, 450.
STOWE, HAROLD CLAIR.—Transferred to Grade of Member, 4.
STRAHAN, CHARLES MORTON.—Transferred to Grade of Member, 490.
STRAIN, BENJAMIN.—Elected a Junior, 162.
STRAUB, THEODORE ALFRED.—Elected a Member, 270.
STRICKLER, FREDERICK WINEMAN.—Elected an Associate Member, 531.
STRICKLER, THOMAS JOHNSON.—Elected an Associate Member, 215.
STROBEL, CHARLES L.—Nominated as Vice-President, 450.
STROHL, RICHARDS MERLE.—Elected a Junior, 268.
STRONG, CARLTON.—Elected a Member, 2.
STROUSE, W. F.—Paper by, 487.
STUART, FRANCIS LEE.—On Publication Committee, 55; On Committee of Arrangements for Annual Convention, 165.
STURGEON, GEORGE BLAIR.—Elected an Associate Member, 267.
SUAREZ Y CORDOVES, PATRICIO ANDRES.—Transferred to Grade of Associate Member, 490.
SULLIVAN, JAMES HENRY.—Elected a Member, 214.
SULLIVAN, JOHN FRANCIS.—Elected an Associate Member, 3.
SULLIVAN, MURRAY.—Elected an Associate Member, 397.
SUN, TAOYUH CLARANCE.—Elected a Junior, 447.
SUNDSTROM, ALFRED YNGVE.—Transferred to Grade of Member, 268.
SWENDSEN, WARREN G.—Elected an Associate Member, 531.
SWENSSON, EMIL.—On Publication Committee, 55.
SWETT, WILLIAM CLAUDE.—Elected a Junior, 489.
SWIFT, WILLIAM EVERETT.—Transferred to Grade of Member, 272.
SYMONS, THOMAS W.—Resignation accepted, 4.

TALBOT, A. N.—Discussion by, 530.
TALLMAN, PAUL BERTRAM.—Transferred to Grade of Associate Member, 398.
TARVER, THOMAS CARY, JR.—Elected an Associate Member, 397.
TATUM, SLEDGE.—Elected a Member, 2.
TAYLOR, EDWARD BALLINGER, JR.—Elected an Associate Member, 397.
TAYLOR, GEORGE BLANEY.—Elected a Junior, 215.
TAYLOR, GORHAM ANDREW.—Elected a Member, 52.
TAYLOR, NORMAN ALFRED.—Death announced. 398.
TAYLOR, W. GAVIN.—Discussion by, 121.
TEBBETTS, GEORGE EDWARD.—Elected an Associate Member, 3.

Tellers.—Appointed to Canvass Ballot for Officers, 49, 57; Report of, 51, 77.

Temple, E. B.—Paper by, 266.

Tenney, William Field.—Elected an Associate Member, 489.

Terry, Arthur Linville, Jr.—Transferred to Grade of Associate Member, 272.

Terry, Francis Marion.—Elected a Junior, 271.

Thayer, Nathaniel Augustine.—Elected a Junior, 162.

"The Arch Principle in Engineering and Esthetic Aspects, and Its Application to Long Spans," presented and discussed, 488.

"The Effect of Alkali on Concrete," presented and discussed, 119.

"The Electrification of the Suburban Zone of the New York Central and Hudson River Railroad in the Vicinity of New York City," awarded the Thomas Fitch Rowland Prize, 52, 55.

"The Failure of the Yuba River Débris Barrier, and the Efforts Made for Its Maintenance," presented and discussed, 529.

"The Improved Water and Sewage Works of Columbus, Ohio," presented and discussed, 121.

"The New York Tunnel Extension of the Pennsylvania Railroad: Contractor's Plant for East River Tunnels," presented and discussed, 1.

"The New York Tunnel Extension of the Pennsylvania Railroad: Meadows Division and Harrison Transfer Yard," presented, 266.

"The New York Tunnel Extension of the Pennsylvania Railroad: The Bergen Hill Tunnels," presented, 161.

"The New York Tunnel Extension of the Pennsylvania Railroad: The East River Tunnels," presented and discussed, 1.

"The New York Tunnel Extension of the Pennsylvania Railroad: The Lining of the Four Permanent Shafts of the East River Division," presented, 445.

"The New York Tunnel Extension of the Pennsylvania Railroad: The Long Island Approaches to the East River Tunnels," presented, 445.

"The New York Tunnel Extension of the Pennsylvania Railroad: The North River Tunnels," presented, 266.

"The New York Tunnel Extension of the Pennsylvania Railroad: The Site of the Terminal Station," presented, 214.

"The New York Tunnel Extension of the Pennsylvania Railroad: The Sunnyside Yard," presented, 445.

"The New York Tunnel Extension of the Pennsylvania Railroad: The Terminal Station—West," presented, 161.

"The Reconstruction of the Passenger Terminals at Washington, D. C.," presented, 487.

"The Sinking of the Piers for the Grand Trunk Pacific Bridge, at Fort William, Ontario, Canada," awarded the Collingwood Prize, 52, 56.

"The Tieton Canal," presented and discussed, 446.

"The Water Supply of the El Paso and Southwestern Railway, from Carrizozo to Santa Rosa, N. Mex.," presented and discussed, 214.

Thompson, Arthur Webster.—Transferred to Grade of Member, 163.

Thompson, Samuel C.—Presides at Meeting, 445.

Thomson, George Huntington.—Death announced, 120.

Thomson, R. H.—On Nominating Committee, 50, 59.

Thomson, T. Kennard.—Paper by, 51, 487; Discussion by, 51, 52, 265, 487.

Thornton, Charles James.—Elected a Member, 396.

Tibbetts, Frank Leslie.—Elected an Associate Member, 3.

Tiernan, A. K.—Resignation accepted, 4.

Tillson, George W.—On Committee on the Licensing of Civil Engineers, 171.

Timberlake, Seth Martin.—Elected a Junior, 122.

TINKHAM, RALPH RUSSELL.—Transferred to Grade of Associate Member, 398.
TOLLES, FRANK CLIFTON.—Elected a Junior, 268.
TOMBO, CARL.—Transferred to Grade of Associate Member, 4.
TOMPKINS, CHARLES HOOK.—Elected an Associate Member, 531.
TOOPS, GEORGE NOBLE.—Elected a Junior, 162; transferred to Grade of Associate Member, 448.
TORRALBAS, RAFAEL JOAQUIN.—Elected a Junior, 489.
TOWSON, M. S.—Resignation accepted, 4.
TRASK, WARREN DUDLEY.—Elected a Junior, 53.
TREADWELL, WILLIAM ADAMS.—Transferred to Grade of Associate Member, 54.
Treasurer.—Report of, 20, 49, 57.
TRELEASE, FRANK JOHNSON.—Elected a Junior, 215.
TROTT, DAVID CROOKER.—Elected an Associate Member, 397.
TRUE, ALBERT OTIS.—Transferred to Grade of Associate Member, 268.
TRUMBULL, MORRIS KINNARD.—Elected a Member, 161.
TWYMAN, A.—Resignation accepted, 4.

UHLER, WILLIAM DAVIS.—Transferred to Grade of Member, 122.
"Underpinning the Cambridge Building, New York City," presented and discussed, 51.
UNGRICH, MARTIN JACOB.—Elected an Associate Member, 121.
UPTON, JOSEPH.—Elected a Junior, 489.

VAN DER HOEK, JACOBUS.—Death announced, 4.
VENT, FREDERICK GOODMAN.—Elected a Member, 214.
VERNON, STEPHEN BARKER.—Elected an Associate Member, 3.
VINCENT, JAMES IRVING.—Elected a Member, 270.
VREDENBURGH, WATSON, JR.—Transferred to Grade of Member, 122.

WADE, GEORGE WILLIS.—Elected an Associate Member, 489.
WADDELL, CHARLES EDWARD.—Elected a Member, 121.
WADDELL, J. A. L.—Awarded the Norman Medal, 52, 55.
WADSWORTH, H. H.—Paper by, 529.
WAGNER, FRED J.—Transferred to Grade of Member, 398.
WAGNER, SAMUEL TOBIAS.—Discussion by, 121.
WAIT, J. C.—Discussion by, 52.
WAITE, DONALD CRAMER.—Transferred to Grade of Associate Member, 163.
WAITT, ARTHUR M.—Resignation accepted, 4.
WALKER, ALBERT WILLARD.—Elected an Associate Member, 215.
WALKER, EMERY LAFAYETTE.—Elected a Member, 214.
WALL, EDWARD WALTER.—Elected a Junior, 531.
WARD, WALTER.—Elected an Associate Member, 215.
WARDLE, EDWARD BEAUMONT.—Transferred to Grade of Member, 268.
WARE, HOWARD THOMAS.—Elected a Junior, 447.
WARING, CHARLES THOMAS.—Elected an Associate Member, 121.
WARLOW, ADONIRAM JUDSON.—Transferred to Grade of Associate Member, 532.
WARNER, GLENN.—Elected a Junior, 3.
WARNER, JOHN ELLIOTT.—Elected an Associate Member, 397.
WASHBURN, DELOS CUYLER.—Elected a Member, 214.
WATERBURY, LESLIE ABRAM.—Transferred to Grade of Associate Member, 272.
WEBER, DANIEL RISHEL.—Elected a Junior, 122.
WEBSTER, FRANK WALLACE.—Death announced, 163.
WEEDIN, KIRBY CALHOUN.—Elected a Member, 161.
WEIDMAN, WILLIAM ROE.—Elected a Member, 52.
WEIDNER, CARL ROBERT.—Transferred to Grade of Associate Member, 163.
WEINSTOCK, HARRY HERSCHEL.—Elected an Associate Member, 271.

WEST, O. J.—On Committee of Arrangements for Annual Convention, 165.
WESTOVER, HENRY CHRISTOPHER.—Transferred to Grade of Associate Member, 163.
WETHERELL, DWIGHT NELSON.—Elected a Junior, 489.
WHEAT, GEORGE NEVILLE.—Elected an Associate Member, 3.
WHEELER, BERTRAND THORP.—Elected a Member, 270.
WHEELER, HARRY ROBERTS.—Transferred to Grade of Member, 122.
WHIPPLE, ROBERT LEE.—Elected an Associate Member, 397.
WHITAKER, RALPH WALLACE.—Elected an Associate Member, 162.
WHITAKER, WILLIAM FRANKLIN.—Transferred to Grade of Associate Member, 398.
WHITBECK, LEE FIELD.—Transferred to Grade of Associate Member, 490.
WHITCOMB, HENRY DONALD.—Death announced, 54.
WHITED, WILLIS.—Transferred to Grade of Member, 490.
WHITMAN, EZRA BAILEY.—Transferred to Grade of Member, 272.
WHITMAN, KILBORN, JR.—Elected a Junior, 397.
WHITNEY, THOMAS BRYAN, JR.—Transferred to Grade of Member, 163.
WHITSIT, LYLE ANTRIM.—Transferred to Grade of Associate Member, 398.
WHITTEMORE, LESLIE CLIFFORD.—Elected a Junior, 215.
WHITTIER, THOMAS TUPPER.—Elected a Member, 266.
WILCOCK, FREDERICK.—Transferred to Grade of Associate Member, 4.
WILCOX, CLARK LUZERNE.—Transferred to Grade of Associate Member, 123.
WILCOX, FRANK LESLIE.—Transferred to Grade of Associate Member, 54.
WILDER, ELLWOOD COGGESHALL.—Elected a Junior, 271.
WILEY, H. L.—Awarded the Collingwood Prize, 52, 56.
WILGUS, W. J.—Awarded the Thomas Fitch Rowland Prize, 52, 55.
WILHELM, GEORGE.—Elected an Associate Member, 447.
WILKERSON, THOMAS JEFFERSON.—Transferred to Grade of Member, 398.
WILKINS, GEORGE SHREVE.—Death announced, 532.
WILKINS, WILLIAM G.—Discussion by, 52; On Finance Committee, 55.
WILLCOX, JAMES DEWITT.—Elected a Junior, 53.
WILLIAMS, ENRIQUE RUIZ.—Elected an Associate Member, 531.
WILLIAMS, GARDNER S.—Presides at Meeting, 51, 488.
WILLIAMS, HAROLD S.—Transferred to Grade of Associate Member, 163.
WILLIAMS, JOHN NORMAN SPENCER.—Elected a Member, 161.
WILLIAMS, LEROY DUNCAN.—Transferred to Grade of Associate Member, 268.
WILLIAMSON, HARRY.—Elected an Associate Member, 447.
WILSON, H. M.—Paper by, 213; Discussion by, 213.
WILSON, RODNEY MELLEDGE.—Elected a Junior, 268.
WILSON, WILLIAM EDWARD.—Transferred to Grade of Member, 272.
WILSON, WILLIAM RENFREW.—Elected an Associate Member, 3.
WILTSEE, WILLIAM PHARO.—Transferred to Grade of Member, 122.
WINSLOW, C.-E. A.—Discussion by, 121.
WINSLOW, CARLILE PATTERSON.—Elected an Associate Member, 121.
WINSOR, HARRY DRAPER.—Elected a Junior, 122.
WOERMANN, FREDERICK CHRISTIAN.—Elected a Member, 530.
WOLFF, LOUIS PETER.—Elected a Member, 270.
WOLFF, MAX W.—Resignation accepted, 4.
WOOD, DETHIC HEWITT.—Transferred to Grade of Member, 490.
Wood, Committee on the Preservation of.—Correspondence Relative to Appointment of, 120; Resolution Relative to Appointment of, 121;

Report of Board of Direction Relative to Appointment of, 269, 273, 282; Discussion on Appointment of, 283.

Woodard, S. H., James H. Brace and Francis Mason.—Paper by, 1.

Woodruff, Charles William.—Elected a Junior, 3.

Worcester, J. R.—On Nominating Committee, 50, 58.

Work, Joe Young.—Elected an Associate Member, 215.

Wright, John Bertram.—Transferred to Grade of Member, 268.

Wright, Joseph.—Discussion by, 159.

Wright, Parker O., Jr.—Elected a Member, 2.

Yarnell, David Leroy.—Elected a Junior, 162.

Yates, E. A.—Discussion by, 51.

Yeo, William Herbert Watt.—Elected an Associate Member, 53.

Young, Samuel McCain.—Transferred to Grade of Member, 398.

Vol. XXXVI. DECEMBER, 1910. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

CONTENTS

Papers:

PAGE

Water Purification Plant, Washington, D. C.: Results of Operation.
By E. D. Hardy, M. Am. Soc. C. E. ... 1560

The Water-Works and Sewerage of Monterrey, N. L., Mexico.
By George Robert Graham Conway, M. Am. Soc. C. E. ... 1621

A Theory of the Water Wave.
By Morton F. Sanborn, Assoc. M. Am. Soc. C. E. ... 1703

Discussions:

The Failure of the Yuba River Débris Barrier, and the Efforts Made for Its Maintenance
By Messrs. William W. Harts and W. C. Hammatt ... 1733

Hydrography as an Aid to the Successful Operation of an Irrigation System.
By Messrs. E. F. Chandler, C. E. Shipman, Clemens Herschel, and Robert Follansbee ... 1737

Bond-Friction-Resistance in Reinforced Concrete.
By Messrs. Edward Godfrey, Joseph T. Maguire, A. N. Talbot, Hector Robins Burroughs, and William Fry Scott ... 1743

Memoirs:

Edwin Peleg Dawley, M. Am. Soc. C. E. ... 1755
Stillman Williams Robinson, M. Am. Soc. C. E. ... 1756
Norman Alfred Taylor, Assoc. M. Am. Soc. C. E. ... 1758
George Higgins Myers, Jun. Am. Soc. C. E. ... 1759

PLATES

Plate CLXXIX. Details of Injector, Sand-Handling System, Washington Aqueduct, D. C., Filtration Plant ... Page 1587
Plates CLXXX to CCX. Illustrations of the Paper entitled "The Water-Works and Sewerage of Monterrey, N. L., Mexico" .. Pages 1623 to 1699

Vol. XXXVI. DECEMBER, 1910. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

WATER PURIFICATION PLANT, WASHINGTON, D. C. RESULTS OF OPERATION.

By E. D. Hardy, M. Am. Soc. C. E.

To be Presented February 15th, 1911.

The Washington filtration plant has already been fully described.* At the time that paper was written (November, 1906), the filtration plant had been in operation for only about 1 year. It has now been in continuous operation for 5 years, and many data on the cost, efficiency, and methods of operation, have accumulated in the various records and books which have been kept. It is thought that a brief review of the results, and a summary of the records in tabular form, will be of interest to the members of the Society, and it is also hoped that the discussion of this paper will bring out the comparative results of operation of other filter plants. As a matter of convenience, the following general description of the plant is given.

Description of the Filtration Plant.—The Washington filtration plant was completed and put in operation in October, 1905. It consists of a pumping station for raising the water from the McMillan Park Reservoir to the filter beds; 29 filters of the slow sand type, having an effective area of 1 acre each; the filtered-water reservoir,

---

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

* "Works for the Purification of the Water Supply of Washington, D. C.," by Allen Hazen and E. D. Hardy, Members, Am. Soc. C. E., *Transactions*, Am. Soc. C. E., Vol. LVII, p. 307.

having a capacity of about 15 000 000 gal.; and the necessary piping and valves for carrying water, controlling rates of filtration, etc.

In the pumping station, there are three centrifugal pumps, which are directly connected to tandem compound engines; two sand-washer pumps; three small electric generating sets for furnishing electric light; and four 200-h.p., water-tube boilers.

Each of the centrifugal pumps has a nominal capacity of 40 000 000 gal. per day when pumping against a head of 21 ft., and each sand-washer pump has a capacity of 2 500 000 gal. when pumping against a head of 250 ft. The electric light engines and generators supply the current for lighting the pumping station, the office and laboratory and other buildings, and also the courts and interior of the filter beds, and for operating a machine-shop.

The filters and filtered-water reservoir are built entirely of concrete masonry. The floors are of inverted groined arches upon which rest the piers for supporting the groined arch vaulting. All this concrete work is similar to that in the Albany, Philadelphia, and Pittsburg filters.

The filters contain, on an average, 40 in. of filter sand and 12 in. of filter gravel. The gravel is graded from coarse to fine; the lower and coarser part acts as part of the underdrain system, and the upper and finest layer supports the filter sand. The raw water from the pumps is carried to the filters through riveted steel rising mains which have 20-in. cast-iron branches for supplying the individual filters. The filtered water is collected in the underdrainage system of the several filter beds, and is carried through 20-in., cast-iron pipes to the regulator-houses. These regulator-houses contain the necessary valves, registering apparatus, etc., for regulating the rate of filtration, showing the loss of head, shutting down a filter, filling a filter with filtered water from the underdrains, and for turning the water back into the raw-water reservoir, or wasting it into the sewer. From the regulator-houses, the filtered water flows directly to the filtered-water reservoir. Generally, five filters are controlled from one house, but there are two cases where the regulator-houses are smaller, and only two filters are controlled from each.

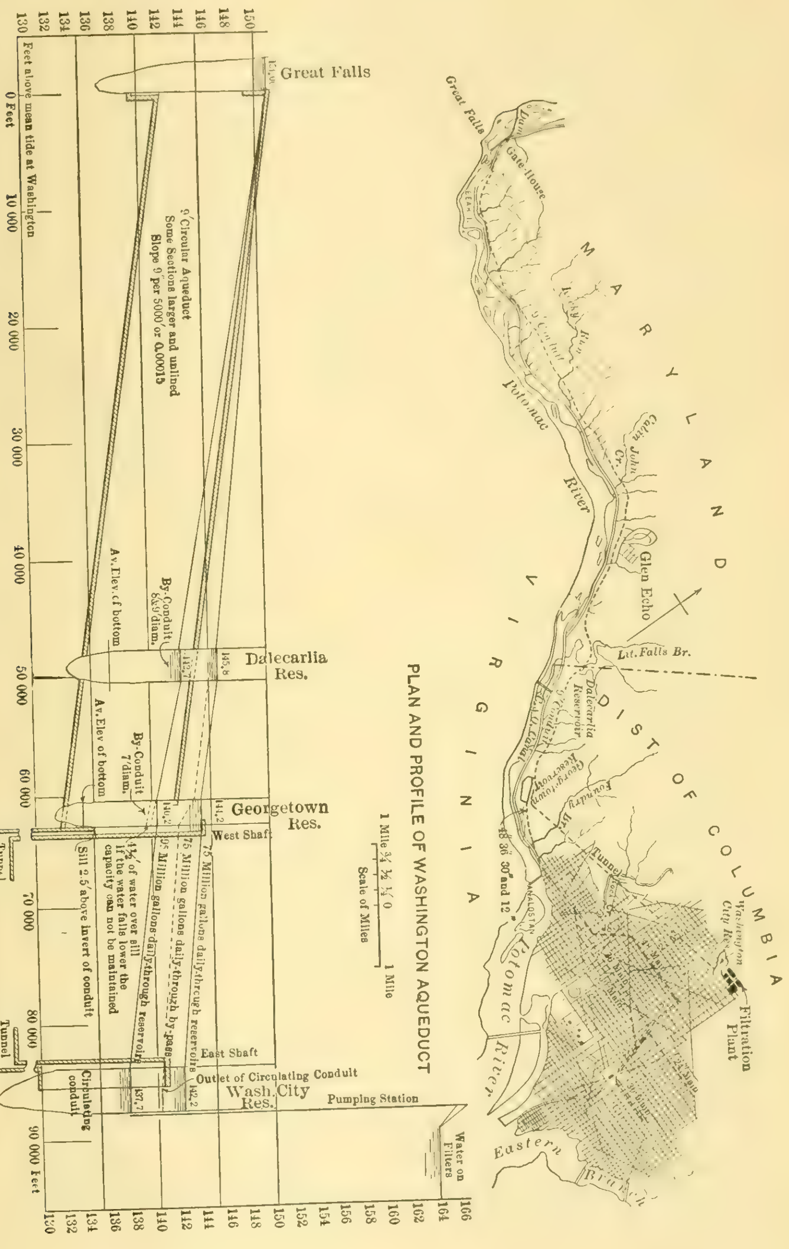
The dirty sand removed from the filters is carried by a portable ejector through one or more lengths of 3-in. hose and a fixed line of 4-in. pipe, to the sand washers. From the sand washers, the washed sand is carried to the reinforced concrete storage bins, each of which has a capacity of 250 cu. yd., and is at such an elevation that carts may be driven under it and loaded through a gate.

Until April, 1909, the sand was replaced in the filters by carts which were filled through the gates in the sand bins. It was then hauled to the top of the filter beds and dumped through the manholes on the chutes, which could be revolved in any direction. These chutes were used to prevent the sand from being unduly compacted in the vicinity of the manholes, and to facilitate spreading it in the filters. Since April, 1909, all the sand has been replaced by the hydraulic method. An ejector is placed under the gate in the sand bin, and the sand is carried in a reverse direction from the bin through the 4-in. piping and one or more lengths of hose to the filter bed. This process has lowered the cost of re-sanding considerably, and present indications are that it will prove entirely satisfactory in every way.

The average effective size and uniformity coefficient of the filters are shown in Table 1.

TABLE 1.—FILTER SAND AS ORIGINALLY PLACED.

Filter No.	Average effective size, in millimeters.	Average uniformity coefficient.	Depth of sand, in inches.	Average turbidity.
1	0.32	1.88	35.3	2 600
2	0.30	1.78	37.7	2 200
3	0.32	1.77	40.2	3 000
4	0.29	1.80	42.5	1 800
5	0.34	1.74	44.9	2 700
6	0.31	1.78	37.7	2 300
7	0.29	1.72	40.1	2 300
8	0.32	1.75	40.2	2 800
9	0.32	1.78	42.5	2 900
10	0.30	1.69	39.5	2 500
11	0.34	1.93	37.1	2 600
12	0.29	1.66	34.7	2 100
13	0.32	1.83	33.6	3 500
14	0.29	1.66	33.6	2 600
15	0.33	1.75	39.0	2 400
16	0.33	1.78	42.3	3 000
17	0.33	1.86	45.5	3 300
18	0.34	1.80	48.7	3 100
19	0.34	1.80	52.0	......
20	0.34	1.87	39.0	2 700
21	0.32	1.82	42.3	2 400
22	0.33	1.74	45.5	2 200
23	0.33	1.81	48.7	2 300
24	0.35	1.80	52.0	2 600
25	0.29	1.64	39.5	2 400
26	0.31	1.71	37.1	2 100
27	0.31	1.71	34.7	1 900
28	0.33	1.93	33.6	2 300
29	0.34	1.93	33.6	3 000
Maximum...	0.36	1.93	52.0	3 300
Minimum....	0.29	1.64	33.6	1 800
Average......	0.32	1.77	40.4	2 600



PLAN AND PROFILE OF WASHINGTON AQUEDUCT

FIG. 1.

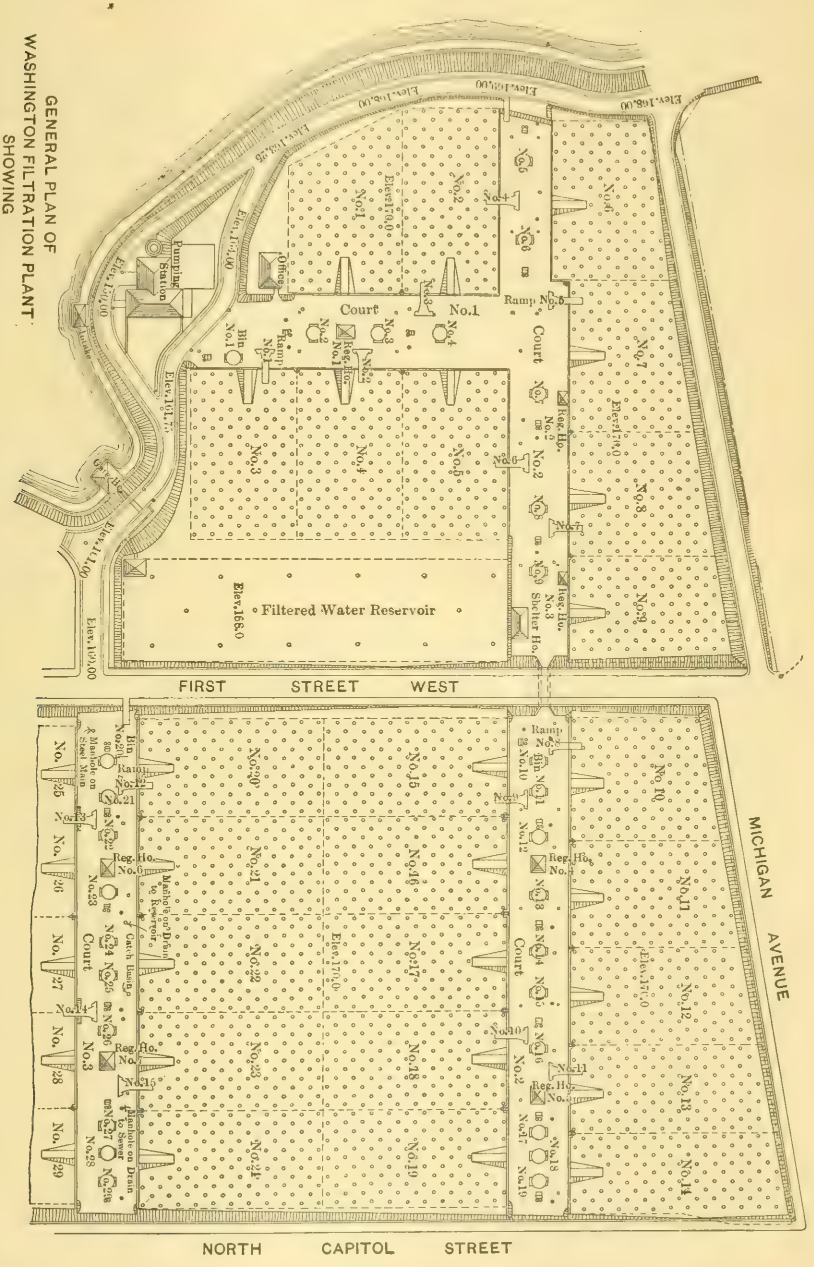
Description of Washington Aqueduct.—The water supply of Washington is taken from the Potomac River, at Great Falls, about 16 miles above the city. At that place, a dam has been built across the river, which holds the water at an elevation of 150.5 ft. above mean tide at Washington. From Great Falls the water flows by gravity for a distance of 16 miles through a 9-ft. conduit, three reservoirs, and a tunnel. From McMillan Park Reservoir, the last of the three, the water is lifted by centrifugal pumps about 21 ft. to the filters. After passing through the filters, it flows to the filtered-water reservoir, and later to the city mains. In its passage from Great Falls to the filters, the water flows through three settling reservoirs, which have already been referred to. These reservoirs are known as the Dalecarlia, the Georgetown, and the McMillan Park Reservoirs, and have available capacities of 141 000 000, 140 000 000, and 180 000 000 gal., respectively.

Turbidity.—The Potomac River water is rather turbid, the turbidity being caused by very fine particles of clay. The river is subject to sudden fluctuations, it being no uncommon thing to have a turbidity of 100 one day, and 1 000 the next. The high turbidity usually disappears about as rapidly as it comes, and is seldom higher than 500 for more than 5 days at a time. It is frequently the case, however, that a succession of waves of high turbidity will appear so close together that the effect of one has not disappeared before that of another is felt.

The clarification of the water supply begins at the dam at Great Falls. Here, it is a clarification by exclusion, for when an excessive quantity of mud appears in the river water, the gates are closed, and the muddy water is allowed to flow over the dam and form mud-bars in the Lower Potomac, while the city is supplied from the water stored in the three settling reservoirs. Until a comparatively recent date, the excessively muddy water was never excluded, having been taken, like other decrees of Providence, as it came.

During the summer of 1907, the practice of shutting out water with a turbidity of 500 or more was established for the warm months. This practice was discontinued during the cold months, as it was feared that a very high consumption of water might occur at the time of low water in the reservoirs, and so cause a partial famine. During the winter of 1909-10, however, the gates were closed, as was the practice throughout the summer months.

When the reservoirs are well filled, and the consumption of water



GENERAL PLAN OF WASHINGTON FILTRATION PLANT SHOWING FINISHED SURFACES is less than 70 000 000 gal. per day, it is safe to close the gates at Great Falls for a period of about 4 days.

While a considerable reduction in turbidity is effected in each of the reservoirs, the bulk of the mud is deposited at the upper end of Dalecarlia Reservoir. This reservoir had become so completely filled, that, in 1905, it was necessary to dredge a channel through the deposit, in order to allow the water to pass it. During the summers of 1907 and 1908, a 10-in. hydraulic dredge removed more than 100 000 cu. yd. of mud which had been deposited in this reservoir. The mud deposited in Georgetown and McMillan Park Reservoirs is so fine that the accumulation of many years is not very noticeable in its effect on the depth of water.

The particles of clay which remain in the water after its passage through the three reservoirs, are so exceedingly small that they do not settle out in any reasonable length of time. Even the filtration of the water through one or more slow sand filters occasionally fails to remove the last trace of turbidity. This is especially true in the colder months, and not a winter has passed when the water supply has not been noticeably turbid at some time.

A general idea of the quantity of mud contained in the river water, the quantity excluded by closing the gates at Great Falls, and that removed by sedimentation and filtration, may be gained from Table 2, which is, of course, only a rough approximation.

Table 2 also shows that the gates were closed 10.50% of the time, thereby excluding 40.06% of the total suspended matter which otherwise would have entered the system.

The turbidities, bacterial counts, and chemical analyses of numerous samples of water are shown in Tables 3, 4, 5, and 6. The amount of work done in the pumping station, average consumption of water, death rate from typhoid fever, and filter runs are shown in Tables 7, 8, 9, and 10.

Raking.—At the time the filters were first put in service, the sand bins had not been completed, and, consequently, the work of cleaning the filters was carried on in the old-fashioned way of scraping by hand and wheeling out the sand in barrows. This method of cleaning was used from October, 1905, to April, 1906; then the regular sand-handling system was commenced.

At times, during the first two summers the filters were in operation, considerable difficulty was experienced in keeping them cleaned as fast as was necessary to provide an ample supply of filtered water. For a short period in each summer it was found necessary to organize night shifts, and keep the work of cleaning in progress for from 16 to 24 hours per day.

TABLE 2.—TONS OF SUSPENDED MATTER ENTERING SYSTEM, ETC.

Month.	Amount that would have entered the system if the gates had been left continuously open.	Number of hours gates were closed.	Amount shut out.	Amount deposited in Dalecarlia Reservoir.	Amount deposited in Georgetown Reservoir.	Amount deposited in McMillan Park Reservoir.	Amount entering filtration plant.	Total.
1909.								
July	318	32.0	3	0	125	74	116	318
August	146	47.0	1	0	78	38	29	146
September	97	57.0	7	21	13	38	18	97
October	61	90.5	8	7	9	25	12	61
November	50	60.0	4	13	5	17	11	50
December	370	99.0	126	108	33	59	44	370
1910.								
January	2 410	136.0	1 109	1 020	67	117	97	2 410
February	839	117.5	481	126	56	75	101	839
March	208	7.5	13	43	15	13	124	208
April	321	65.0	17	195	43	43	23	321
May	197	84.5	58	54	22	24	39	197
June	1 505	124.0	786	535	49	88	47	1 505
Total	6 522	920.0	2 613	2 122	515	611	661	6 522

In order to relieve the situation at such times, the expedient of raking was tried. This was first attempted with the filters filled with water; the effluent was first shut off in order to prevent a downward flow of water, and the filter was then raked or harrowed from boats. This method was not satisfactory, however, as the work was neither as uniform nor as thorough as necessary. Later, the filters were drained to the necessary depth, and the surface of the sand was thoroughly stirred with iron garden rakes. The filters were then filled with filtered water through the underdrains and put in service.

This latter method proved so satisfactory that it has been resorted to at all times when the work was at all pressing. When the runs were of short duration, and the depth to which the mud had penetrated the filter sand was slight, a raking seemed to be nearly as effective in restoring the filter capacity as a scraping; it could be done in 8 hours by 3 laborers, and there seemed to be no ill effects from lowered efficiency.

TABLE 3.—TURBIDITIES.

Average by Months.

(United States Geological Survey Standard.)

Month.	Great Falls.		RESERVOIRS:							
			Dalecarlia Outlet.		Georgetown Outlet.		McMillan Park Outlet.		Filtered water.	
1905.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.
October	100	36	40	21	32	18	20	11	4	1
November	35	19	34	19	22	14	14	11	3	1
December	1 500	199	250	84	150	74	95	39	14	6
1906.										
January	700	94	180	60	120	60	85	52	20	12
February	120	45	85	41	55	29	35	22	5	3
March	1 750	272	350	181	120	56	90	46	8	6
April	1 270	167	180	72	95	58	75	46	12	7
May	600	56	50	20	45	16	34	10	3	2
June	1 700	303	500	125	450	94	180	41	13	2
July	1 000	130	180	54	150	47	250	43	13	3
August	1 530	375	250	112	95	66	65	45	5	2
September	120	33	180	34	95	28	75	25	7	2
October	1 025	127	110	37	60	24	55	21	1	1
November	160	27	75	20	45	16	24	13	1	1
December	600	69	110	31	80	28	80	26	8	2
1907.										
January	400	135	150	70	110	75	70	53	11	7
February	55	26	26	15	36	16	40	17	5	2
March	950	248	180	77	130	70	90	57	7	4
April	200	47	80	33	60	30	45	24	4	2
May	130	29	40	18	26	15	14	9	1	1
June	400	104	160	48	75	32	40	18	1	1
July	600	114	130	61	78	47	45	31	1	1
August	800	73	130	35	85	26	30	14	1	0
September	600	129	*	*	150	51	70	28	1	0
October	75	32	*	*	65	28	75	26	4	0
November	300	97	*	*	100	45	45	23	2	1
December	680	135	*	*	180	61	100	46	10	4
1908.										
January	2 100	202	340	73	250	82	160	65	20	7
February	3 000	302	300	52	150	52	75	32	7	4
March	300	91	150	78	100	68	65	42	5	4
April	75	23	65	41	37	27	26	20	3	2
May	2 000	172	130	48	85	37	50	20	1	1
June	400	40	70	29	40	24	30	18	1	1
July	1 500	149	....	74	170	44	75	15	0	0
August	900	129	200	*	150	56	85	39	2	1
September	75	24	*	*	50	19	35	18	0	0
October	95	20	*	*	55	18	28	15	0	0
November	24	11	*	*	20	11	19	10	0	0
December	20	9	17	11	14	9	10	7	0	0
1909.										
January	400	72	95	32	60	23	25	16	4	1
February	650	194	120	64	90	51	55	35	4	3
March	250	51	*	*	90	44	60	37	8	4
April	750	98	*	*	130	42	76	31	2	1
May	480	57	*	*	30	19	30	12	2	1
June	650	141	*	*	120	51	80	30	1	0

* Reservoirs out of service.

TABLE 3.—(*Continued.*)

Month.	Great Falls.		Reservoirs:							
			Dalecarlia Outlet.		Georgetown Outlet.		McMillan Park Outlet.		Filtered water.	
1909.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.
July..........	400	48	*	*	215	46	120	35	2	1
August.......	180	23	*	*	50	17	18	9	0	0
September...	26	16	24	14	*	*	25	6	0	0
October......	14	10	15	10	11	9	8	4	0	0
November....	11	9	11	8	10	8	6	4	0	0
December....	600	63	110	31	80	28	50	15	3	0
1910.										
January......	3 000	357	200	58	150	53	115	30	5	2
February	3 000	143	150	55	120	50	100	36	7	4
March.........	210	36	100	35	95	38	100	43	9	5
April	350	55	100	25	55	18	25	8	1	0+
May...........	300	33	55	19	50	17	28	13	1	0+
June	1 500	246	180	42	110	37	50	16	1	0+
Fiscal years:										
1905–06†.......	1 750	133	500	70	450	47	180	31	20	5
1906–07........	1 530	114	250	46	150	37	250	29	13	2
1907–08........	3 000	117	340	53	250	45	160	31	20	2
1908-09........	1 500	79	200	50	170	32	85	22	8	1
1909–10........	2 100	86	200	30	215	29	120	18	9	1

* Reservoirs out of service. † October to June 30th.

TABLE 4.—Bacteria.

Averages by Months.

Month.	Reservoirs:				
	Dalecarlia Inlet.	Dalecarlia Outlet.	Georgetown Outlet.	McMillan Park Outlet.	Filtered water.
1905.					
October......	......	......	.....	210	80
November...	......	..... .	.....	150	27
December ...	......	15 500	.....	3 800	60
1906.					
January.....	......	2 800	.....	1 500	39
February....	2 900	4 100	1 800	550	16
March.......	1 800	1 100	900	650	19
April	3 300	1 700	700	400	22
May.........	425	210	95	65	17
June.........	7 900	4 600	325	220	17
July.........	13 500	600	475	160	26
August......	8 700	1 100	1 200	190	14
September ..	425	250	140	135	14
October	2 300	950	650	270	16
November...	1 800	1 100	1 200	220	12
December ...	6 900	3 800	3 600	700	45

TABLE 4.—(*Continued.*)

Month.	Reservoirs:				
	Dalecarlia Inlet.	Dalecarlia Outlet.	Georgetown Outlet.	McMillan Park Outlet.	Filtered water.
1907.					
January	4 400	2 400	2 200	950	70
February	1 000	950	1 000	700	45
March	11 500	8 300	7 200	3 600	65
April	3 700	2 100	1 400	475	21
May	750	350	325	130	26
June	2 300	1 000	600	100	18
July	2 700	575	350	160	17
August	3 000	275	425	80	17
September	6 200	*	1 900	230	32
October	1 400	*	950	275	27
November	8 900	*	6 600	1 500	27
December	16 000	*	9 600	4 300	190
1908.					
January	11 000	8 700	9 400	3 700	190
February	11 500	6 000	5 000	2 800	75
March	4 600	4 000	2 900	1 300	30
April	700	450	250	120	13
May	9 500	1 100	650	325	17
June	750	120	110	95	12
July	4 900	.....	400	150	8
August	1 600	325	300	100	12
September	325	*	200	80	11
October	375	*	325	140	8
November	550	*	300	200	12
December	800	750	375	170	23
1909.					
January	11 000	2 700	1 600	700	31
February	8 000	3 500	2 400	1 300	60
March	3 800	*	2 600	1 000	39
April	2 200	*	1 400	550	12
May	900	*	350	140	16
June	3 400	*	1 200	170	21
July	550	*	500	250	33
August	400	*	325	55	18
September	325	240	*	70	18
October	350	275	250	130	20
November	600	500	500	180	13
December	21 000	9 100	5 900	4 500	250
1910.					
January	76 000	78 000	88 000	52 000	800
February	45 000	35 500	31 000	17 500	350
March	9 900	7 600	7 400	4 800	80
April	7 900	4 100	3 500	650	29
May	1 230	810	830	448	28
June	3 660	930	800	324	27
Fiscal years:					
1905–06	3 300†	4 300‡	750§	850†	33†
1906–07	4 900	1 900	1 700	650	31
1907–08	6 300	2 700	2 900	1 300	55
1908–09	3 100	2 000	950	400	21
1909–10	14 300	13 900	10 900	6 800	143

* Reservoirs out of service.
† October to June 30th.
‡ December to June 30th.
§ February to June 30th.

TABLE 5.—Results of Tests for *Bacillus Coli.*

Percentage Positive.

Month.	Great Falls, or Dalecarlia Reservoir Inlet.			Dalecarlia Reservoir Outlet.			Georgetown Reservoir.			McMillan Park Reservoir (applied water).			Filtered-water reservoir.		Tap water from various parts of city.	
	10 c. c.	1 c. c.	0.1 c. c.	10 c. c.	1 c. c.	0.1 c. c.	10 c. c.	1 c. c.	0.1 c. c.	10 c. c.	1 c. c.	0.1 c. c.	10 c. c.	1 c. c.	10 c. c.	1 c. c.
1906.																
*January	55.6	38.9	22.2	69.2	23.1	7.7	56.0	40.0	8.0	55.6	22.2	0	7.2	0	....	....
February	33.3	26.7	6.7	26.1	17.4	8.7	30.4	13.0	4.4	8.3	4.2	0	0	0	....	....
March	50.0	12.5	0	45.5	18.2	0	20.8	8.3	0	18.5	7.4	3.7	0	0	0	0
April	72.2	33.3	16.7	95.5	50.0	4.6	59.1	22.7	4.6	32.0	8.0	0	4.0	0	0	0
May	20.0	8.0	4.0	20.0	12.0	0	7.8	0	0	0	0	0	0	0	0	0
June	57.7	38.5	19.2	40.0	32.0	8.0	50.0	34.6	0	23.1	7.7	3.8	0	0	3.1	0
July	65.0	50.0	5.0	60.0	25.0	10.0	15.0	5.0	5.0	9.5	0	0	4.8	0	....	....
August	84.6	69.2	61.5	88.5	65.4	34.6	80.0	57.7	23.1	63.0	33.3	0	7.4	3.7	11.9	5.1
September	50.0	10.0	0	30.0	10.0	10.0	40.0	10.0	0	32.0	12.0	0	8.0	0	3.1	0
October	60.0	30.0	10.0	55.5	33.3	0	80.0	60.0	20.0	48.1	22.2	3.7	3.7	0	13.0	3.7
November	37.5	0	0	25.0	12.5	12.5	37.5	25.0	0	20.0	12.0	0	8.0	0	0	0
December	55.5	44.5	0	66.7	44.5	22.2	66.7	22.2	0	20.8	8.3	4.2	16.7	8.3	7.5	0
1907.																
January	77.8	33.3	22.2	66.7	33.3	0	55.5	55.5	22.2	69.3	34.6	3.8	19.2	11.5	14.0	0
February	37.5	25.0	0	12.5	0	0	37.5	12.5	0	17.4	4.4	0	0	0	2.9	0
March	87.5	50.0	0	75.0	37.5	0	50.0	25.0	0	30.8	7.7	0	0	0	2.1	0
April	44.5	11.1	11.1	66.7	22.2	11.1	77.8	11.1	11.1	46.1	19.2	3.8	3.8	0	3.2	0
May	91.3	65.2	17.4	88.9	33.3	0	87.5	50.0	12.5	23.1	0	0	0	0	1.4	0
June	80.0	68.0	24.0	87.5	62.5	0	66.7	44.5	11.1	40.0	8.0	0	0	0	0	0
July	42.3	30.8	19.2	25.0	12.5	0	22.2	22.2	0	3.8	0	0	0	0	1.4	1.4
August	48.1	29.6	3.7	33.3	16.7	16.7	36.4	18.2	0	14.8	3.7	0	0	0	0	0
September	62.5	54.1	25.0	....	....	....	41.7	33.3	16.7	16.0	4.0	0	4.0	0	1.7	0
October	51.9	40.8	7.4	....	....	....	53.3	40.0	6.7	38.7	25.8	9.7	6.5	0	12.5	2.8
November	80.0	64.0	24.0	....	....	....	72.7	54.5	0	58.6	17.3	3.5	0	0	4.9	0
December	56.0	48.0	16.0	....	....	....	46.2	38.5	7.7	45.2	29.0	0	19.3	3.2	12.9	4.3
1908.																
January	46.2	30.8	15.4	50.0	12.5	0	33.3	0	0	22.6	9.7	3.2	3.2	0	1.9	1.9
February	12.5	0	0	25.0	0	0	12.5	0	0	0	0	0	0	0	0	0
March	38.5	19.2	7.7	44.4	11.1	0	11.1	0	0	9.7	0	0	0	0	0	0
April	15.4	7.7	0	0	0	0	0	0	0	6.7	3.3	0	0	0	0	0
May	76.0	52.0	40.0	87.5	50.0	12.5	33.3	22.2	0	45.1	16.2	0	0	0	0	0
June	7.7	0	0	0	0	0	11.1	0	0	0	0	0	0	0	0	0
July	26.9	15.4	11.5	22.2	22.2	0	11.1	0	0	6.4	6.4	0	0	0	0	0
August	46.2	26.9	3.9	44.4	33.3	0	62.5	25.0	12.5	12.9	3.2	0	0	0	1.6	0
September	20.0	8.0	4.0	42.9	28.6	1.4	22.2	11.1	0	16.7	10.0	0	0	0	4.3	0
October	18.4	3.7	0	0	0	0	9.1	0	0	9.7	6.4	3.2	0	0	0	0
November	13.0	0	0	28.6	0	0	11.1	0	0	6.6	0	0	0	0	0	0
December	11.5	7.7	3.8	0	0	0	12.5	0	0	3.2	0	0	0	0	0	0
1909.																
January	12.0	8.0	0	30.0	10.0	0	0	0	0	3.2	3.2	0	3.2	0	0	0
February	52.1	47.8	47.8	28.6	14.3	0	37.5	0	0	7.1	3.6	3.6	0	0	3.4	3.4
March	69.4	34.6	3.8	50.0	25.0	0	44.5	11.1	0	32.3	19.4	3.2	6.5	0	2.8	1.4
April	42.3	15.4	3.9	33.3	22.2	11.1	44.4	22.2	11.1	36.6	10.0	0	0	0	0	0
May	88.4	26.1	4.3	50.0	12.5	0	33.3	0	0	12.9	3.2	0	0	0	0	0
June	85.0	60.0	25.0	60.0	40.0	10.0	44.4	33.3	11.1	53.3	20.0	0	0	0	1.4	0

* Presumptive tests.

TABLE 5.—(*Continued.*)

Month.	Great Falls, or Dalecarlia Reservoir Inlet.			Dalecarlia Reservoir Outlet.			Georgetown Reservoir.			McMillan Park Reservoir (applied water).			Filtered-water reservoir.		Tap water from various parts of city.	
	10 c. c.	1 c. c.	0.1 c. c.	10 c. c.	1 c. c.	0.1 c. c.	10 c. c.	1 c. c.	0.1 c. c.	10 c. c.	1 c. c.	0.1 c. c.	10 c. c.	1 c. c.	10 c. c.	1 c. c.
1909.																
July	34.8	8.7	4.4	....	....	....	33.3	11.1	0	25.8	12.9	0	0	0	0	0
August	50.0	15.4	7.7	....	....	....	40.0	10.0	0	22.6	6.5	3.2	0	0	0	0
September	43.5	21.8	8.7	25.0	25.0	12.5	0	0	0	13.3	3.3	0	0	0	0	0
October	36.4	13.6	0	18.2	0	0	0	0	0	3.2	0	0	0	0	0	0
November	4.5	0	0	10.0	0	0	0	0	0	0	0	0	0	0	0	0
December	38.5	23.1	7.7	36.4	36.4	18.2	33.3	22.2	11.1	29.0	22.6	0	9.7	6.5	7.3	1.5
1910.																
January	72.0	48.0	24.0	44.5	33.3	11.1	75.0	25.0	0	61.3	35.5	9.7	25.8	3.2	15.9	3.2
February	47.8	43.5	17.4	63.2	21.1	5.3	40.0	30.0	5.0	32.2	7.1	0	3.6	0	9	0
March	33.3	14.8	0	30.8	11.1	3.7	29.6	22.2	7.4	12.9	3.2	0	0	0	0	0
April	41.7	33.3	20.8	40.0	32.0	16.0	38.5	23.1	15.4	23.3	13.3	0	0	0	0	0
May	47.8	17.4	0	52.0	20.0	0	36.0	16.0	4.0	16.1	12.9	0	0	0	0	0
June	95.5	86.4	31.8	80.8	46.2	19.2	64.0	28.0	8.0	43.3	6.7	0	0	0	1.4	0
Fiscal years:																
1905-06	35.2	19.4	9.3	40.0	23.2	5.2	26.4	14.9	1.7	24.3	8.3	1.8	2.3	1.8	1.3	0
1906-07	61.5	43.6	19.2	57.7	29.2	12.3	51.1	29.8	10.7	32.5	13.0	1.4	4.5	2.1	5.4	1.0
1907-08	44.6	31.3	13.0	32.3	12.3	3.1	34.4	22.1	4.1	22.2	9.4	1.4	2.8	0.3	3.1	0.9
1908-09	38.9	20.3	8.4	30.0	15.0	0	27.4	8.5	2.8	16.7	7.1	0.8	0.8	0	1.2	0.4
1909-10	45.5	26.9	10.1	45.3	24.0	8.8	37.9	19.8	6.2	23.6	10.4	1.1	3.3	0.8	2.2	0.4

TABLE 6.—SUMMARY OF SANITARY CHEMICAL ANALYSES OF WEEKLY SAMPLES, JULY 1ST, 1909, TO JUNE 30TH, 1910.

(Results in Parts per Million.)

(*A*) MAXIMUM.

Reservoirs.	Turbidity.*	Ammonia.			Nitrogen as:		Hardness.	Alkalinity.	Chlorine.
		Free.	Albuminoid.	Total.	Nitrites.	Nitrates.			
Dalecarlia inlet	2 100	0.034	0.264	0.280	0.0070	0.45	120.0	106.0	5.4
Dalecarlia outlet†	200	0.034	0.180	0.206	0.0050	0.70	115.0	105.8	5.7
Georgetown outlet‡	215	0.030	0.182	0.182	0.0060	0.60	115.0	105.0	4.9
McMillan Park outlet	120	0.028	0.126	0.154	0.0060	0.65	118.0	104.4	4.2
Filtered water	9	0.016	0.078	0.086	0.0010	0.70	119.5	106.3	4.5

(*B*) MINIMUM.

Reservoirs.	Turbidity.*	Free.	Albuminoid.	Total.	Nitrites.	Nitrates.	Hardness.	Alkalinity.	Chlorine.
Dalecarlia inlet	7	0.000	0.016	0.016	0.0000	0.00	52.9	39.5	1.0
Dalecarlia outlet†	7	0.000	0.040	0.040	0.0000	0.00	54.3	38.2	0.9
Georgetown outlet‡	7	0.000	0.044	0.044	0.0000	0.00	51.4	40.6	0.7
McMillan Park outlet	2	0.000	0.010	0.010	0.0010	0.00	51.4	38.5	0.2
Filtered water	0	0.000	0.000	0.000	0.0000	0.00	52.9	40.3	0.4

* Summary of daily samples of water.

† Reservoir out of service from July 1st to September 13th, 1909.

‡ Reservoir out of service from September 10th to October 4th, 1909.

TABLE 6.—(*Continued.*)

(*C*) AVERAGE.

Reservoirs.	Turbidity.*	AMMONIA.			NITROGEN AS:		Hardness.	Alkalinity.	Chlorine.
		Free.	Albuminoid.	Total.	Nitrites.	Nitrates.			
Dalecarlia inlet.......	86	0.006	0.107	0.113	0.0027	0.19	93.2	81.4	2.9
Dalecarlia outlet†.....	30	0.008	0.106	0.114	0.0023	0.18	95.5	79.5	3.4
Georgetown outlet‡...	29	0.005	0.101	0.106	0.0027	0.18	93.4	80.9	2.9
McMillan Park outlet.	18	0.004	0.077	0.081	0.0027	0.17	94.0	83.0	2.7
Filtered water........	1	0.002	0.027	0.029	0.0000	0.19	94.9	84.0	2.8

* Summary of daily samples of water.
† Reservoir out of service from July 1st to September 13th, 1909.
‡ Reservoir out of service from September 10th to October 4th, 1909.

No chemical determinations were made during February, March, April, and May, 1910, on account of the rearrangement of the laboratory and equipment.

TABLE 7.—DAILY RESULTS AT PUMPING STATION.

(A)

Month.	MILLION GALLONS PUMPED:						Lift to filters.	Pressure at sand-washer pumps, per square inch.	COAL CONSUMED PER DAY, IN TONS.			STATION DUTY, PER 100 LB. OF COAL CONSUMED.		
	To filters.			To sand washers.										
	Max.	Min.	Ave.	Max.	Min.	Ave.			Max.	Min.	Ave.	Max.	Min.	Ave.
1909.														
July	76.16	57.65	64.05	1.140	0.298	0.730	24.18	110.0	13.4	8.4	10.8	67.8	52.3	61.4
August	69.31	54.44	61.42	0.629	0.157	0.441	22.18	110.0	12.4	8.0	10.1	64.2	49.5	56.6
September	66.02	52.82	60.32	0.831	0.207	0.572	22.26	110.0	12.7	8.7	10.5	61.0	48.9	55.1
October........	78.50	48.12	59.18	0.761	0.060	0.467	21.84	110.0	13.4	8.0	10.3	59.6	49.1	53.6
November	64.92	49.83	55.25	0.468	0.141	0.272	20.49	110.0	11.3	7.9	9.2	55.6	45.7	51.1
December......	67.83	48.32	56.77	0.307	0.039	0.174	20.54	110.0	10.3	8.5	9.5	61.0	45.4	50.4
1910.														
January.......	70.04	51.02	62.49	0.499	0.008	0.156	22.43	110.0	12.7	9.1	10.4	59.6	49.8	54.9
February......	70.79	55.19	60.28	0.284	0.041	0.173	21.44	112.3	12.3	8.7	10.2	57.4	44.8	51.5
March..........	59.11	51.64	56.04	0.409	0.063	0.171	19.76	120.0	10.5	7.8	9.2	53.2	45.2	49.8
April	66.53	53.79	58.32	0.715	0.167	0.474	20.78	120.0	11.1	8.1	9.7	58.7	47.2	53.7
May	61.93	54.55	57.76	0.525	0.059	0.254	20.30	120.0	10.1	7.4	8.8	60.7	48.1	54.9
June...........	70.49	50.42	58.37	0.281	0.124	0.207	21.19	117.3	12.3	7.4	9.1	60.1	49.9	54.4
Fiscal years:														
1909–10...	78.50	48.12	59.19	1.140	0.008	0.373	21.45	113.3	13.4	7.4	9.8	67.8	44.8	54.0
1905–06*........	80.59	57.18	66.07	2.062	0.089	0.747	21.71	107.4	14.8	6.4	8.9	79.6	48.2	62.8
1906–07.........	80.29	57.44	66.89	2.120	0.023	0.580	21.60	120.8	15.0	7.0	10.0	71.6	46.5	58.6
1907–08.........	80.38	54.35	64.91	0.735	0.017	0.347	22.20	125.0	12.0	7.2	9.6	70.7	51.3	60.3
1908–09.........	78.93	47.83	61.47	0.875	0.060	0.453	22.52	122.3	13.2	7.0	10.0	74.0	45.7	57.7

* Raw water shut off from city supply on October 5th.

TABLE 7.—(*Continued.*)

(B)

Fiscal year.	Name of coal used.	Cost per ton.	Duty per 100 lb. of coal consumed.	Cost of coal per 1 000 000 ft-lb. of work performed.
1905–06..........	George's Creek Big Vein........	$3.34	62.8	$0.00238
1906–07..........	" " " "	3.43	58.6	0.00261
1907–08..........	" " " "	3.75	60.3	0.00278
1908–09..........	Orenda	3.47	57.7	0.00268
1909–10..........	"	†3.15	54.0	0.00255

† Corrected for increase or decrease in ash and British thermal units as determined by United States Geological Survey.

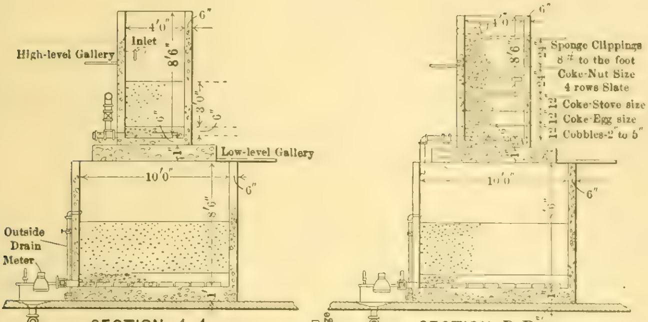
TABLE 8.—AVERAGE CONSUMPTION OF WATER FOR TWENTY-FOUR HOURS, PER MILLION GALLONS.

Month.	FISCAL YEARS.							
	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
July	59.80	61.50	63.20	69.80	69.18	68.64	71.08	64.05
August	59.00	59.70	67.70	71.40	68.03	67.74	68.14	61.42
September	56.50	61.10	67.90	71.30	69.82	68.93	65.83	60.32
October	58.70	59.10	63.90	68.40	69.14	66.46	65.89	59.18
November..................	54.70	58.60	62.10	66.10	65.51	61.54	60.06	55.25
December	60.70	60.10	70.30	67.20	65.71	62.29	57.99	56.77
January.....................	60.10	65.30	75.10	65.30	67.62	63.36	57.72	62.49
February...................	59.30	67.80	86.00	68.70	74.68	68.17	55.42	60.28
March.......................	55.30	60.00	67.60	64.30	64.23	59.63	55.31	56.04
April	55.10	57.20	63.10	62.70	63.45	61.51	58.19	58.32
May	57.70	60.80	66.30	65.60	62.47	62.96	59.25	57.76
June.........................	59.50	62.30	70.60	67.80	63.53	67.96	60.12	58.37
Average	58.03	61.10	68.70	67.40	66.90	64.91	61.47	59.19

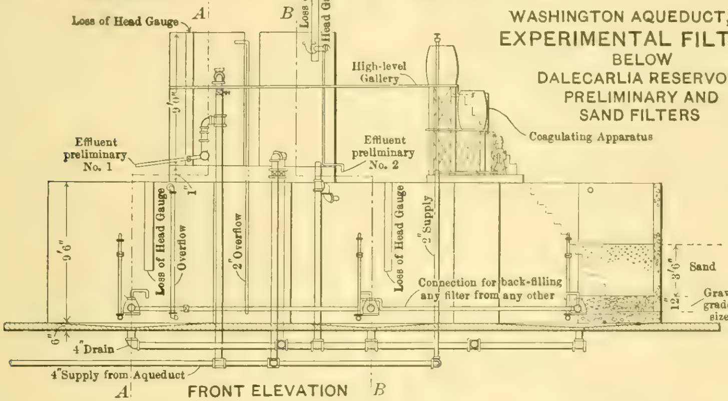
The length of runs, depth of scraping, etc., after the scraping or raking, are shown in Tables 10 and 11.

Sand Handling.—For the first three years of operation, the sand was carried from the sand bins in carts and dumped through the numerous manholes of the filters on chutes which could be revolved in various directions, in order to facilitate the spreading of the sand evenly over the surface of the filter.

About a year ago, however, this method was changed, by substituting sand ejectors for the carts. By this method, an ejector is either attached to, or placed directly under, the outlet gate of the sand bin, the gate is opened, and the ejector is started. From this ejector,

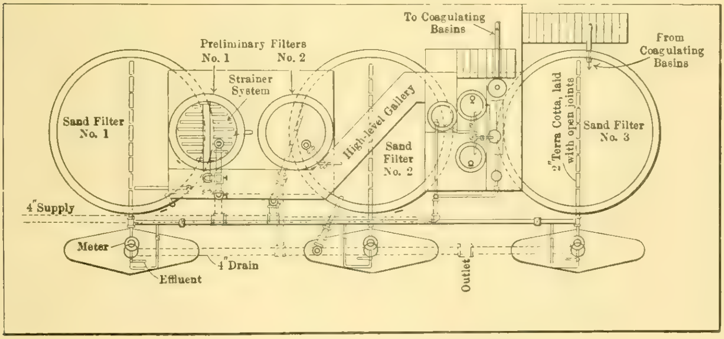


SECTION *A-A* SECTION *B-B*



WASHINGTON AQUEDUCT, D.C.
EXPERIMENTAL FILTERS
BELOW
DALECARLIA RESERVOIR
PRELIMINARY AND
SAND FILTERS

FRONT ELEVATION



PLAN OF FILTER-HOUSE AND EQUIPMENT

FIG. 3.

the sand is carried back through the line of 4-in. fixed pipe, and one or more lengths of 3-in. hose, to the point of discharge in the filter bed which is being re-sanded.

TABLE 9.

(*A*) NUMBER OF DEATHS FROM TYPHOID FEVER, BY MONTHS, IN THE DISTRICT OF COLUMBIA FOR THE LAST FOURTEEN FISCAL YEARS.

Fiscal year.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Total.
1896–97....	8	15	25	25	18	16	13	4	4	4	6	9	147
1897–98....	10	16	18	10	9	18	8	4	2	9	6	20	130
1898–99....	24	22	22	28	21	16	10	4	7	6	3	6	169
1899–1900..	9	38	30	28	27	26	17	6	8	10	5	12	216
1900–01....	20	41	29	25	28	17	7	2	8	2	4	10	193
1901–02....	16	33	28	21	22	16	19	8	12	9	13	9	206
1902–03....	21	39	25	32	19	20	9	5	9	6	6	3	194
1903–04....	17	26	18	19	8	14	5	5	6	10	8	8	144
1904–05....	16	22	25	14	11	9	11	1	5	7	1	3	125
1905–06*...	15	30	23	26	14	6	6	4	5	4	10	9	152
1906–07....	21	32	21	25	17	4	7	6	4	6	7	2	152
1907–08....	10	18	17	19	11	7	4	1	1	8	8	3	107
1908–09....	15	13	23	17	16	13	16	8	3	8	7	7	146
1909–10....	12	12	17	12	12	2	3	4	7	5	5	4	95
Average..	15.3	25.5	22.9	21.5	16.6	13.1	9.6	4.4	5.8	6.7	6.4	7.5	155.4

(*B*) NUMBER OF DEATHS FROM TYPHOID FEVER REDUCED TO DEATH RATES PER 100 000 INHABITANTS PER YEAR.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Annual death rate.
1896–97......	35	65	109	109	78	70	56	17	17	17	26	39	53
1897–98......	43	69	78	43	39	78	34	17	8	38	25	85	46
1898–99......	102	93	93	119	89	68	42	17	29	25	12	25	59
1899–1900....	37	158	125	116	112	108	69	24	33	41	20	49	74
1900–01......	82	167	118	102	114	69	28	8	32	8	16	40	65
1901–02......	64	132	112	84	88	64	75	31	47	35	51	35	68
1902–03......	83	153	98	126	75	79	35	19	35	23	23	12	63
1903–04......	66	100	69	73	31	54	19	19	23	38	30	30	46
1904–05......	61	83	95	53	42	34	41	4	19	26	4	11	39
1905–06......	56	111	85	97	52	22	22	15	18	15	36	33	47
1906–07......	69	105	69	82	56	13	24	20	13	20	24	7	42
1907–08......	35	64	60	67	39	25	14	4	4	28	28	11	32
1908–09......	53	45	80	60	56	45	56	28	10	28	24	24	43
1909–10......	42	42	60	42	42	7	11	14	24	17	17	14	28
Average monthly death rate.	59	99	89	84	65	53	38	21	22	26	24	30	..

* Filtered water supplied since October, 1905.

TABLE 10.—Periods of Operation, and Quantities Filtered.

Month.	Number of filter runs ended after:		Number of days since previous:						Million gallons filtered since previous:					
			Scraping.			Raking.			Scraping.			Raking.		
	Scraping.	Raking.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1909.														
July.........	14	0	89	44	67.4	0	0	0	229.01	106.27	163.289	0	0	0
August......	8	0	74	51	60.4	0	0	0	175.54	124.94	152.581	0	0	0
September...	13	0	98	53	68.3	0	0	0	237.52	114.37	161.702	0	0	0
October......	18	5	81	32	59.9	43	33	39.4	206.09	78.78	132.359	96.50	71.51	82.708
November...	8	2	79	44	53.4	47	37	42.0	168.19	82.32	112.603	99.00	90.23	94.615
December...	3	4	62	61	61.3	63	50	57.3	135.77	128.33	132.647	144.35	106.11	125.940
1910.														
January.....	9	4	95	79	88.0	88	72	77.0	204.38	146.58	178.461	189.48	152.33	170.735
February....	1	4	99	99	99.0	93	51	71.0	205.73	205.73	205.730	192.98	118.85	158.890
March........	3	4	120	110	113.7	108	101	104.3	275.96	257.36	265.493	249.68	224.49	238.993
April........	10	12	126	62	84.8	129	21	65.3	295.96	104.13	181.972	307.57	45.22	142.448
May.........	3	2	86	38	69.7	55	32	43.5	186.64	81.66	150.230	102.15	69.79	85.978
June.........	13	2	100	61	79.7	129	78	103.5	213.70	130.85	171.059	181.25	167.84	174.540
Year 1909–10..	103	39	126	32	71.1	129	21	66.6	295.96	81.66	159.151	307.57	45.22	143.832
Fiscal years:														
1905–06.......	71	0	195	38	91.1	0	0	0	497.45	116.66	240.379	0	0	0
1906–07.......	101	4	199	24	77.0	32	14	21.7	466.12	69.76	220.693	103.28	32.13	76.870
1907–08.......	143	77	180	11	54.9	63	7	28.6	477.19	28.20	146.912	165.25	17.08	75.775
1908–09.......	128	50	135	11	49.9	93	13	34.2	298.08	39.26	125.617	244.19	41.41	88.439

In re-sanding a filter, it is first filled with water to the proposed depth of the sand layer. The outlet end of the hose is connected to a 3-in. pipe which is supported on a boat, and the sand is discharged through this pipe at the point required. Work is first begun at the far end of the filter, and it is gradually filled by swinging the boat from side to side and backing it by degrees to the front end.

At first it was feared that a small quantity of mud would be deposited on the surface of the old sand, and that this mud would ultimately cause subsurface clogging. For this reason, when this method was first adopted, a man was required to rake the sand very thoroughly in front of the discharge. Later, it was found that by giving the end of the discharge pipe a slope of about 45° downward from the horizonal, the force of the current of sand and water could be depended on to cut the old surface of sand to any required depth, and move it ahead together with the new sand, thus completely breaking up the possible mud layer between the old and new sand layers. After having used this method almost exclusively for 15 months, in which time eleven filters have been re-sanded, and 24 531 cu. yd. of sand have been replaced, there seems to be no indication of an increased initial loss of head. The sand is very compact, and has no apparent tendency to separate into different sizes. The general appearance is similar to that of very fine sand on the seashore. The filters re-sanded in this way have been considerably more efficient than those in which the sand was replaced with carts, and as yet, no harmful results have been noted. The rate at which the sand is replaced is shown in Table 12, and the cost of labor for sand handling is given in detail in Table 14, which shows that quite a perceptible saving has been effected by the hydraulic method.

The figures showing the cost for sand handling do not include any charge for the quantity of water used, that item having been carried on the pumping-station account.

TABLE 11.—QUANTITIES OF SAND REMOVED.

Month.	No. of filters scraped when last treatment was:		Cubic yards when last treatment was:						Depth, in inches, when last treatment was:					
	Scraping.	Raking.	Scraping.			Raking.			Scraping.			Raking.		
			Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1909.														
July	14	0	338	121	190.6	0	0	0	2.51	0.90	1.415	0	0	0
August	8	0	356	149	218.5	0	0	0	2.65	1.11	1.631	0	0	0
September	8	0	524	97	178.6	0	0	0	3.90	0.72	1.330	0	0	0
October	9	5	150	93	115.8	301	121	169.0	1.12	0.69	0.862	2.24	0.90	1.256
November	2	2	134	88	111.0	132	81	106.5	1.00	0.65	0.825	0.98	0.60	0.790
December	0	2	0	0	0	133	126	129.5	0	0	0	0.99	0.94	0.965
1910.														
January	2	4	155	112	133.5	195	121	147.8	1.15	0.83	0.990	1.45	0.90	1.100
February	0	4	0	0	0	390	160	225.8	0	0	0	2.90	1.19	1.678
March	1	4	489	489	489.0	262	179	214.3	3.64	3.64	3.640	1.95	1.33	1.593
April	4	12	172	84	119.3	230	146	178.8	1.28	0.62	0.885	1.71	1.09	1.331
May	1	2	320	320	320.0	249	241	245.0	2.38	2.38	2.380	1.85	1.79	1.820
June	0	2	0	0	0	203	190	196.5	0	0	0	1.51	1.41	1.460
Year 1909-10	49	37	524	84	176.7	390	81	181.0	3.90	0.62	1.314	2.90	0.60	1.373
Fiscal Years:														
1905–06	71	0	600	71	250.0	0	0	0	4.47	0.53	1.799	0	0	0
1906–07	94	2	536	52	259.0	398	276	337.0	4.00	0.56	1.931	2.95	2.05	2.500
1907–08	81	53	527	46	190.2	411	35	118.4	3.92	0.21	1.507	3.06	0.21	0.881
1908–09	92	50	580	55	169.5	472	81	177.5	4.31	0.41	1.259	3.51	0.60	1.317

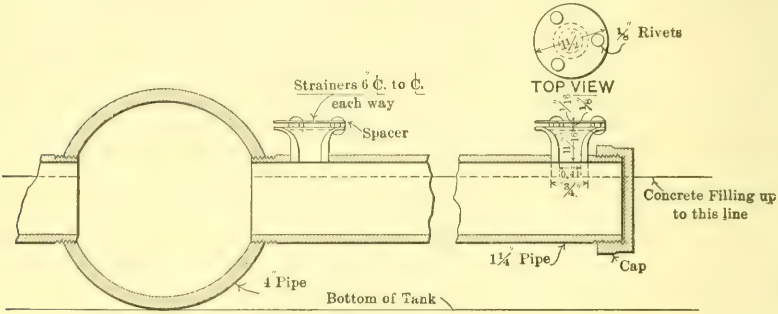
TABLE 12.—RATES OF SAND HANDLING.

Date.	SAND REMOVED FROM FILTERS.			SAND REPLACED IN FILTERS.		
	Ejector hours.	Cubic yards of sand removed.	Average rate, in cubic yards per hour.	Ejector hours.	Cubic yards of sand removed.	Average rate, in cubic yards per hour.
1906.						
April	49	253	5.2	......	......	......
May	380	2 511	6.6	......	......	......
June	567	3 280	5.8	......	......	......
July	931	5 376	5.8	......	......	......
August	105	533	5.1	......	......	......
September	315	1 892	6.0	......	......	......
October	1 067	6 173	5.8	......	......	......
November	168	935	5.6	......	......	......
December	203	1 073	5.3	......	......	......
1907.						
January	399	2 974	7.3	......	......	......
February	140	1 139	8.1	......	......	......
March	115	878	7.6	......	......	......
April	427	3 103	7.3	......	......	......
May	133	939	7.0	......	......	......
June	105	674	6.4	......	......	......
July	7	46	6.6	......	......	......
August	90	574	6.4	......	......	......
September	306	1 996	6.5	......	......	......
October	273	1 701	6.2	......	......	......
November	202	1 258	6.3	......	......	......
December	364	2 138	5.9	......	......	......
1908.						
January	546	3 708	6.8	......	......	......
February	98	776	7.9	......	......	......
March	315	2 832	9.0	......	......	......
April	469	3 775	8.1	......	......	......
May	182	1 414	7.8	......	......	......
June	280	2 057	7.4	......	......	......
July	280½	2 683	9.6	......	......	......
August	327½	2 808	8.6	......	......	......
September	402	3 371	8.4	......	......	......
October	308	2 696	8.7	......	......	......
November	47½	333	7.0	......	......	......
December	153¾	1 268	8.3	......	......	......
1909.						
January	119½	1 055	8.8	......	......	......
February	161½	1 479	9.2	......	......	......
March	144	1 465	10.2	......	......	......
April	214¾	2 260	10.5	188	2 405	12.8
May	219¾	2 223	10.1	190	2 196	11.5
June	355	3 096	8.7	243	3 054	12.6
July	312¼	2 707	8.7	425½	4 050	9.5
August	218¾	1 955	9.0	64½	620	9.6
September	172½	1 360	7.9	408	2 842	7.0
October	203	1 870	9.2	261¼	2 350	9.0
November	54	397	7.4	0	0	......
December	62	382	6.2	0	0	......
1910.						
January	104	703	6.8	0	0	......
February	106½	1 058	9.9	28¼	371	13.1
March	98	985	10.0	72	1 008	14.0
April	268¾	2 852	10.7	134¼	2 159	16.1
May	58¾	693	11.8	171¾	3 042	17.7
June	58¾	642	10.9	9¾	166	17.0

The cost for pumping water for sand handling, including all labor, materials, and repairs, amounts to $0.06 per cu. yd. of sand ejected and washed, and $0.03 per cu. yd. for replacing.

In addition to the water used for carrying the sand which is being replaced, it is customary to keep a slight upward flow in the filter, thus using about 500 000 gal. of filtered water per day for this purpose. Assuming the value of this water to be the total cost for pumping, filtering, etc., or $3.80 per 1 000 000 gal., the cost per cubic yard of sand replaced would be about $0.02 when one ejector is used, and $0.01 when two are in operation.

It is not considered absolutely necessary to have an upward flow of water in the filter which is being re-sanded, and it is not always done. It was used, however, as an additional safeguard against the formation of a stratum of mud between the old and new layers of sand while the hydraulic method was in an experimental stage.



DETAIL OF STRAINER SYSTEM

FIG. 4.

The quantities of sand removed from the filters per scraping and the rates of sand handling are shown in Tables 11 and 12.

Cost of Operation.—It is frequently difficult to compare the relative cost of corresponding items for different plants, because of the different methods of dividing the cost and the varying opinions of the officials as to what should properly be charged to each item.

In order that the data may be in sufficient detail to permit it to be rearranged to compare with other plants, a list of employees and charges for supplies is given in Table 13. This list accounts for the entire appropriation for the care and maintenance of the filtration plant, including pumping the water to the filters, parking and caring for the grounds, buildings, roads, sidewalks, etc. The cost for the

TABLE 13.—List of Employees, Rates of Pay, and Approximate Cost for Supplies.

1 Superintendent	$3 000.00
1 Chief Chemist and Assistant Superintendent	2 100.00
1 First Assistant Chemist	1 500.00
1 Second Assistant Chemist	1 000.00
1 Stenographer and Clerk	1 200.00
1 Surveyor	1 200.00
1 Laboratory Helper	720.00
1 Janitor	600.00
1 Chief Steam Engineer	1 800.00
1 First Assistant Steam Engineer	1 440.00
1 Second Assistant Steam Engineer	1 080.00
3 Oilers, at $900 each	2 700.00
3 Firemen, at $900 each	2 700.00
3 Laborers, at $540 each	1 620.00
1 Filter Foreman	1 200.00
2 Foremen, at $900 each	1 800.00
1 Timekeeper	900.00
3 Watchmen and Gauge Tenders, at $900 each	2 700.00
1 Machinist	1 140.00
1 Blacksmith	900.00
1 Storekeeper	900.00
1 Painter	900.00
1 Mechanic	900.00
1 Electrician	900.00
4 Skilled Laborers at $600 each	2 400.00
1 Watchman and Special Officer	900.00
1 Recorder	720.00
27 Laborers, at $1.50 per day for 300 days	12 150.00
3 Teams, at $2.00 per day for 200 days	1 200.00
Laboratory and office supplies	2 700.00
Filter supplies, tools, hose, repair of roads, parks, shrubs, etc	8 820.00
Pumping station supplies, oil, waste, packing, repairs, etc	3 570.00
3 600 tons of coal, at $3.15 per ton	11 340.00
Charges in U. S. Engineer Office, labor	2 900.00
“ “ “ “ “ materials	400.00
Total	$82 000.00

various items per million gallons pumped to the filters is shown in Table 14, and the cost per cubic yard of sand handled in Table 15.

Preliminary Treatment.—Before the present filtration plant was designed, Rudolph Hering, George W. Fuller, and Allen Hazen, Members, Am. Soc. C. E., made an investigation and report. This report was dated February 18th, 1901, and contained the following paragraph:

"In consideration of the full evidence, we recommend the construction of a complete system of slow or sand filters, with such auxiliary works as may be necessary for preliminary sedimentation, and the use of a coagulant for part of the time. There is no reason to believe that the use of this coagulant will in any degree affect the wholesomeness of the water."

Notwithstanding this opinion, considerable prejudice existed among the citizens of Washington against the use of a coagulant, and, as finally passed, the bill providing for the construction of the filters did not include an appropriation for the coagulant.

TABLE 14.—COST PER MILLION GALLONS FILTERED.

(*A*) LABOR.

Month.	Office and laboratory.	Pumping station.	FILTER OPERATIONS:		Parking (care of grounds), etc.	Experimental filters.	Main office.	Total.
			Sand handling.	Repairs, etc.				
1909.								
July	$0.73	$0.57	$0.86	......	$0.31	......	$0.15	$2.62
August	0.75	0.64	0.59	......	0.71	......	0.14	2.83
September	0.83	0.67	0.80	......	0.51	......	0.17	2.98
October	0.72	0.66	0.73	......	0.34	......	0.08	2.53
November	0.87	0.76	0.42	......	0.38	......	0.18	2.61
December	0.90	0.69	0.27	......	0.40	......	0.12	2.38
1910.								
January	0.81	0.63	0.33	......	0.14	......	0.10	2.01
February	0.94	0.74	0.35	$0.07	0.11	......	0.16	2.37
March	0.92	0.81	0.30	0.07	0.18	......	0.13	2.41
April	0.93	0.83	0.49	0.03	0.36	......	0.13	2.77
May	0.86	0.72	0.36	0.03	0.55	......	0.18	2.70
June	0.88	0.67	0.38	......	0.38	......	0.12	2.43
Average	0.84	0.70	0.27	*0.25	0.36	......	0.14	2.56
Fiscal years:								
1905-1906	0.45	0.45	0.47	0.02	0.01	......	0.09	1.49
1906-1907	0.57	0.57	0.58	0.21	0.07	$0.03	0.04	2.07
1907-1908	0.70	0.59	0.42	0.32	0.15	0.09	0.09	2.36
1908-1909	0.72	0.61	0.41	0.34	0.22	0.01	0.13	2.44

(*B*) MATERIALS.

1909.								
July	......	......	$0.01	......	......	......	......	$0.01
August	$0.01	......	......	......	$0.07	......	$0.01	0.09
September	0.05	$0.31	0.04	......	0.01	......	0.03	0.44
October	0.08	0.11	0.13	......	0.46	......	0.02	0.80
November	0.13	0.78	0.10	......	0.34	......	0.02	1.37
December	0.03	0.17	0.05	......	0.01	......	0.05	0.31
1910.								
January	0.12	0.74	0.14	......	0.01	......	......	1.01
February	0.07	1.88	0.18	......	0.01	......	0.01	2.15
March	0.26	0.28	0.01	......	......	......	......	0.55
April	0.18	1.22	0.10	......	0.29	......	0.02	1.81
May	0.06	0.72	0.02	......	0.11	......	0.02	0.93
June	0.54	2.23	......	$†2.16	0.46	.....	0.04	5.43
Average	0.13	0.69	0.02	‡0.21	0.17	......	0.02	1.24
Fiscal years:								
1905-1906	0.04	0.59	0.02	......	......	......	......	0.65
1906-1907	0.03	0.67	0.08	0.20	0.02	......	......	1.00
1907-1908	0.05	0.54	0.04	0.07	0.06	......	0.01	0.77
1908-1909	0.10	0.69	0.05	0.18	0.18	......	0.02	1.22

* $0.02 for new sand-handling system.

† $2.02 " " "

‡ $0.16 " " "

TABLE 14.—(*Continued.*)

(*C*) TOTALS.

Month.	Office and laboratory.	Pumping station.	FILTER OPERATIONS: Sand handling.	FILTER OPERATIONS: Repairs, etc.	Parking (care of grounds), etc.	Experimental filters.	Main office.	Total.
1909.								
July	$0.73	$0.57	$0.87	......	$0.31	......	$0.15	$2.63
August	0.76	0.64	0.59	......	0.78	......	0.15	2.92
September...	0.88	0.98	0.84	......	0.52	......	0.20	3.42
October	0.80	0.77	0.86	......	0.80	......	0.10	3.33
November ...	1.00	1.54	0.52	......	0.72	......	0.20	3.98
December....	0.93	0.86	0.32	......	0.41	......	0.17	2.69
1910.								
January	0.93	1.37	0.47	......	0.15	......	0.10	3.02
February	1.01	2.62	0.53	$0.07	0.12	......	0.17	4.52
March	1.18	1.09	0.31	0.07	0.18	......	0.13	2.96
April	1.11	2.05	0.59	0.03	0.65	......	0.15	4.58
May	0.92	1.44	0.38	0.03	0.66	......	0.20	3.63
June	1.42	2.90	0.38	2.16	0.84	......	0.16	7.86
Average	0.97	1.39	0.29	0.46	0.53	......	0.16	3.80
Fiscal years:								
1905-1906......	0.49	1.04	0.49	0.02	0.01	......	0.09	2.14
1906-1907......	0.60	1.24	0.66	0.41	0.09	$0.03	0.04	3.07
1907-1908......	0.75	1.13	0.46	0.39	0.21	0.09	0.10	3.13
1908-1909......	0.82	1.30	0.46	0.52	0.40	0.01	0.15	3.66

The results obtained from operating the filters being such as to justify the conclusions in the report referred to, an experimental plant was constructed for the purpose of studying the efficiency of various methods of preliminary treatment of the water. This plant consisted of three cylindrical concrete filter tanks, each 10 ft. in diameter. These tanks were filled with the layers of gravel and sand necessary to make them represent as accurately as possible the large slow sand units of the main filtration plant. Means were also provided for giving a preliminary treatment to the water supplying each of these experimental slow sand filters. In two cases, the preliminary treatment was rapid filtration, while the third consisted of sedimentation and coagulation. The sedimentation tank was of sufficient size, when compared with the area of the experimental slow sand filter, to represent the Georgetown and McMillan Park Reservoirs when used in connection with the large filters. The first preliminary filter was very similar in construction and operation to a mechanical filter. The sand for this filter was taken from the main filters, and, consequently, was finer than is generally used in mechanical filters. The second preliminary filter was a Maignen scrubber. It consisted of a cylindrical concrete tank, 4 ft. in diameter and 8½ ft. deep, which contained 12 in. of cobble-stones on the bottom, then, successively, of 12 in. of egg-size coke, 12 in. of stove-size coke, 24 in. of nut-size coke, and 24 in. of sponge clippings as the final or top layer.

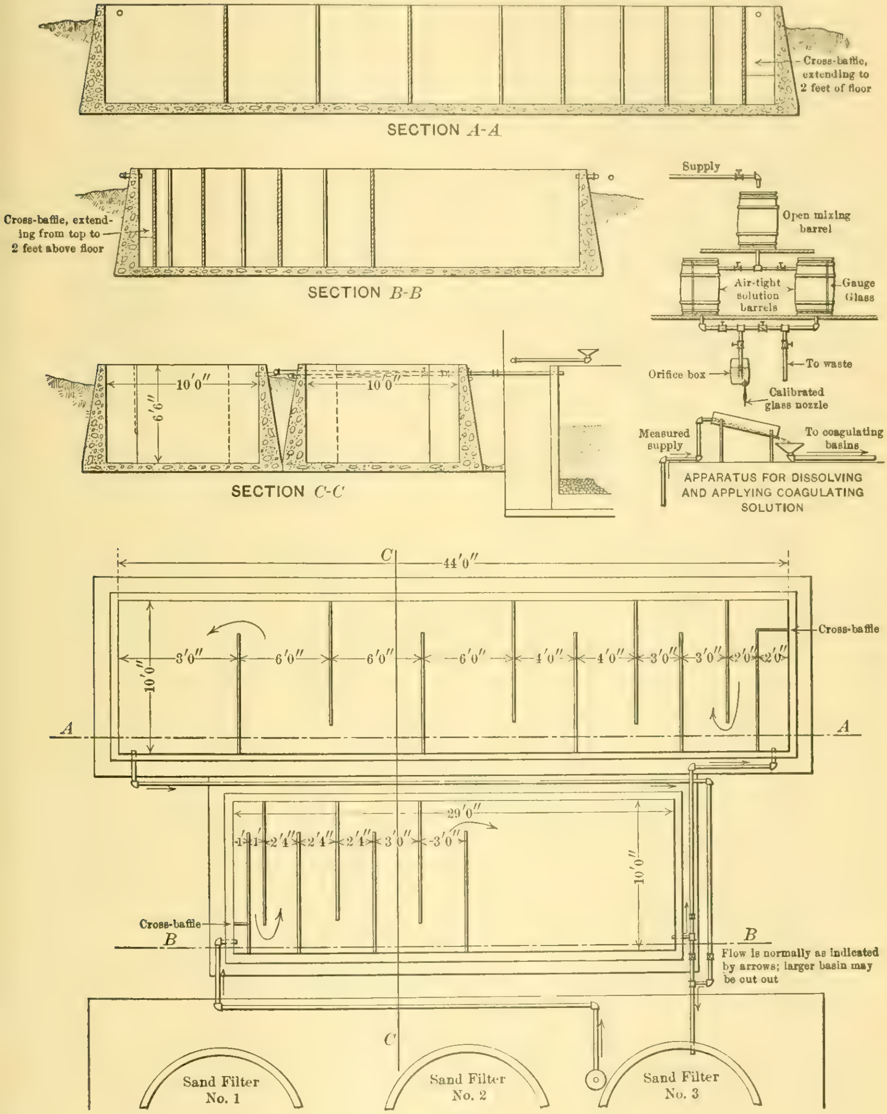
TABLE 15.—AVERAGE COST FOR LABOR FOR SAND HANDLING.

(*A*) PER MILLION GALLONS PUMPED TO FILTER.

Month.	Scraping.	Ejecting,	Washing.	Smoothing.	Raking.	Re-sanding.	Total.
1909.							
July	$0.10	$0.21	$0.03	$0.02	....	$0.21	$0.57
August	0.07	0.16	0.03	0.01	....	0.04	0.31
September	0.05	0.13	0.02	0.01	$0.01	0.27	0.49
October	0.06	0.15	0.03	0.01	0.02	0.12	0.39
November	0.02	0.06	....	....	0.02	....	0.10
December	0.02	0.04	0.01	....	0.01	0.01	0.09
1910.							
January	0.04	0.07	....	0.01	0.02	....	0.14
February	0.04	0.10	....	0.01	....	0.02	0.17
March	0.04	0.06	....	0.01	0.01	0.05	0.17
April	0.10	0.15	0.04	0.01	0.02	0.06	0.38
May	0.02	0.03	0.01	....	0.01	0.11	0.18
June	0.02	0.04	....	....	0.02	0.01	0.09
Average	0.05	0.10	0.01	0.01	0.01	0.08	0.26
Fiscal years:							
1905-06	0.06	0.29	0.02	0.06	....	0.04	0.47
1906-07	0.07	0.20	0.05	0.02	....	0.24	0.58
1907-08	0.09	0.14	0.03	0.01	0.02	0.13	0.42
1908-09	0.07	0.15	0.03	0.01	0.01	0.14	0.41

(*B*) PER CUBIC YARD OF SAND.

1909.							
July	$0.08	$0.15	$0.03	$0.01	....	$0.10	$0.37
August	0.07	0.15	0.03	0.01	....	0.11	0.37
September	0.07	0.17	0.03	0.01	....	0.17	0.45
October	0.06	0.15	0.03	0.01	....	0.09	0.34
November	0.10	0.23	0.02	0.02	....	....	0.37
December	0.12	0.25	0.04	0.02	....	0.08	0.51
1910.							
January	0.10	0.19	....	0.02	....	....	0.31
February	0.07	0.15	....	0.01	....	0.09	0.32
March	0.06	0.11	....	0.02	....	0.08	0.27
April	0.07	0.09	0.03	0.01	....	0.05	0.25
May	0.06	0.09	0.03	0.01	....	0.06	0.25
June	0.06	0.12	....	0.01	....	0.10	0.29
Average	0.07	0.14	0.02	0.01	....	0.10	0.34
Fiscal years:							
1905-06	0.07	0.35	0.04	0.07	....	0.14	0.67
1906-07	0.06	0.19	0.03	0.02	....	0.17	0.47
1907-08	0.09	0.15	0.03	0.01	....	0.14	0.42
1908-09	0.06	0.14	0.03	0.01	....	0.13	0.37



WASHINGTON AQUEDUCT, D.C.
EXPERIMENTAL FILTERS BELOW DALECARLIA RESERVOIR
COAGULATING BASINS AND APPARATUS

FIG. 5.

The two preliminary filters were operated at a rate of about 50 000 000 gal. per acre per day, and the three slow sand filters at rates of from 3 000 000 to 4 000 000 gal. per day.

This plant was put in service during the early part of February, 1907, and was kept in practically continuous operation until the end of July, 1908.

For convenience in referring to the different systems, the combined rapid and slow sand filter will be designated as Filter Plant No. 1, the combined Maignen scrubber and slow sand filter as Filter Plant No. 2, and the combined coagulating basin and slow sand basin as Filter Plant No. 3.

The length of run of Filter Plant No. 1 was relatively long at first. The rapid rate of filtration, however, tended to carry the clay, which was suspended in the applied water, to a considerable depth in the filtering material, so that the runs gradually decreased in length until they were reduced to about three days. Unfortunately, it was necessary to use unfiltered water for washing, which, together with the great penetration from the applied water, finally made it necessary to remove all the filtering materials, and wash them.

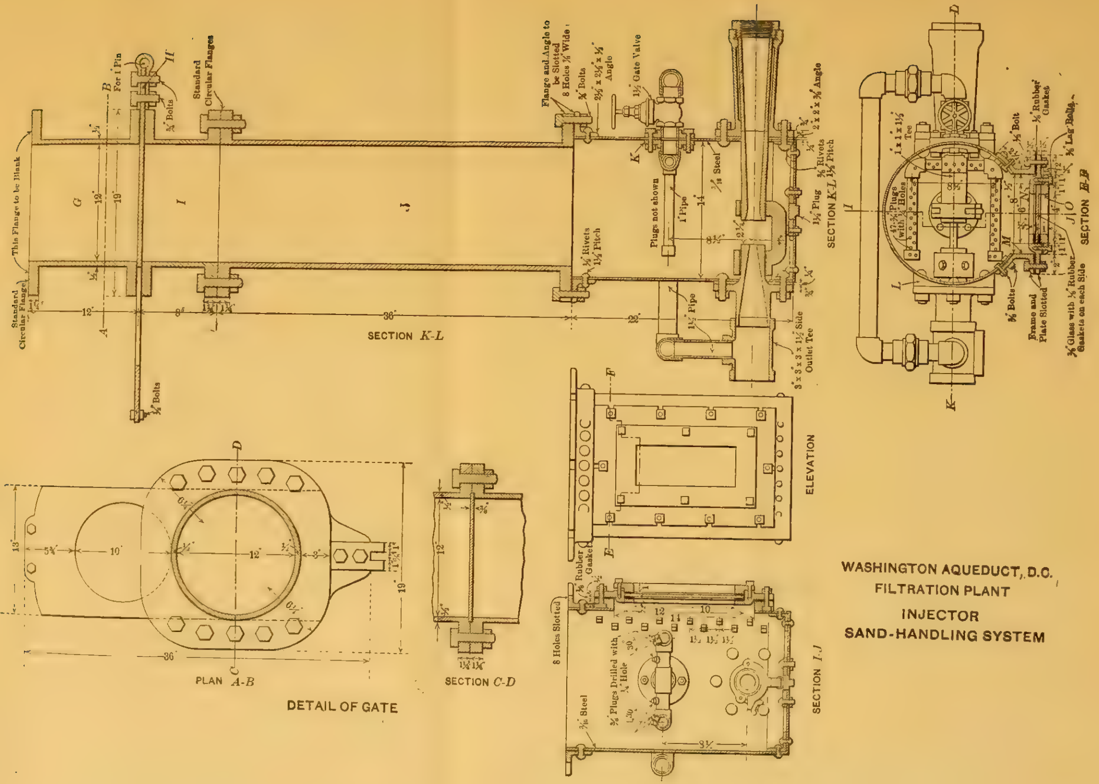
Although this preliminary filter was operated at a high rate, its efficiency was quite satisfactory. In fact, at times when the applied water was comparatively good, very little work was left for the slow sand filter. At times of high turbidity, however, some of the exceedingly fine mud in the applied water passed through this filter, as well as the slow sand filter connected with it, and it proved to be absolutely impossible to produce a clear effluent at all times with this combination.

Filter Plant No. 2 proved more economical and convenient in operation, but somewhat less efficient than Filter Plant No. 1. Neither filter could be depended on to give a clear effluent when the applied water was turbid.

In the operation of Filter Plant No. 3, sulphate of alumina was used when the applied water contained too much turbidity to be treated satisfactorily by slow sand filters.

When the water was comparatively clear, either one of the three systems, or slow sand filtration alone, was entirely satisfactory. At times of high turbidity, however, Filter Plant No. 3 was the only one which could be depended on to produce a clear effluent.

PLATE CLXXIX.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
HARDY ON
WASHINGTON WATER FILTRATION PLANT.



SECTION K-L

SECTION K-L

SECTION E-F

ELEVATION

SECTION I-J

PLAN A-B

SECTION C-D

DETAIL OF GATE

WASHINGTON AQUEDUCT, D.C.
FILTRATION PLANT
INJECTOR
SAND-HANDLING SYSTEM

A fair comparison between the results of the three systems when treating turbid water in January, 1908, is given in Table 16.

TABLE 16.—TURBIDITY RESULTS WITH EXPERIMENTAL FILTERS, DURING PERIOD OF HIGH TURBIDITY, JANUARY, 1908.

Date.	Raw water.	FILTER NO. 1.		FILTER NO. 2.		FILTER NO. 3.	
		Effluent, preliminary filter.	Effluent, sand filter.	Effluent, preliminary filter.	Effluent, sand filter.	Effluent, coagulant basin.	Effluent, sand filter.
January 12th...	40	10	1	12	1	2	0
" 13th...	110	45	2	51	2	2	0
" 14th...	210	95	3	113	4	2	0
" 15th...	325	190	12	222	15	3	0
" 16th...	360	210	37	247	42	5	0
" 17th...	242	122	24	147	26	6	0
" 18th...	137	...	..	73	7	6	0
" 19th...	117	40	12	cleaning	..	5	0
" 20th...	72	31	6	sand filter	..	cleaning.	0
" 21st...	55	20	4	25	4	sand	..
" 22d....	49	17	3	21	4	filter	..
" 23d....	40	12	3	15	3	3	0
" 24th...	40	11	3	13	3	3	0

Table 16 shows very clearly that neither Filter Plant No. 1 nor No. 2 would prove at all satisfactory when treating turbid water, while No. 3 could be depended on under all conditions. The results of operation are shown in detail in Tables 17, 18, and 19. It will be noticed in Table 17, that on March 10th, 1908, Filter Plant No. 1 was put out of service and a Puech system of preliminary filters was substituted for it.

The Puech preliminary filters consisted of five units containing gravel of varying sizes through which the water was filtered successively before it was finally applied to the final slow sand filter. A general idea of this system may be obtained by referring to Fig. 6.

It is unfortunate that this system was not in operation in January, 1908, when the water was cold and turbid. The results, however, indicate that it would be no more successful than either Filter Plant No. 1 or No. 2.

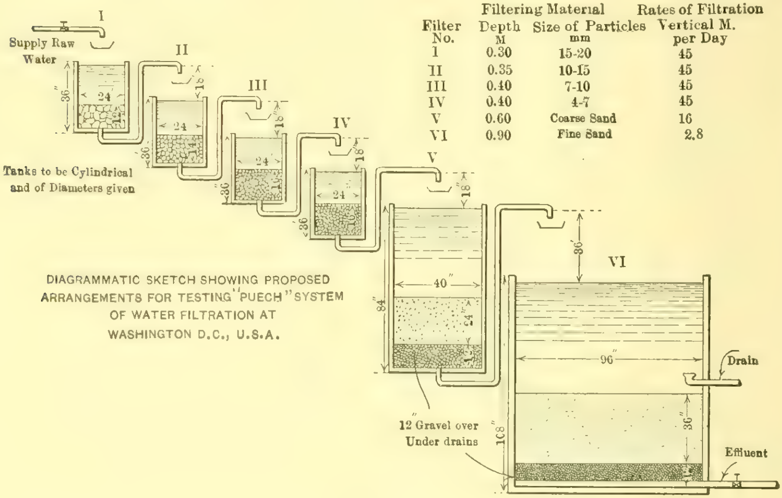
Experimental Rate Studies.—In September, 1908, an experimental plant consisting of six small filters was put in operation. The object of these experiments was to study the relative efficiencies and cost for the operation of slow sand filters when operated at different rates.

The units of the plant consisted of cylindrical galvanized-iron tanks

4 ft. in diameter and 9 ft. high. The filter sand in these tanks was taken from the supply for the main filters. It was supported on gravel layers and supplied with underdrains of suitable sizes for the proposed rate of flow in each case.

The units of the experimental plant were designated as Nos. 1, 2, 3, 4, 5, and 6, and it was the original intention to operate them at rates of 1 000 000, 3 000 000, 6 000 000, 10 000 000, 30 000 000, and 100 000 000 gal. per acre daily, respectively.

This schedule of rates was carried out in a general way with all the filters, with the exception of Nos. 5 and 6. For these, the rates were found to be higher than could be maintained for any great length of time, owing to the deeper penetration of the mud in the filter sand, which caused high initial losses of head, short runs, and deep scrapings. A rate of about 30 000 000 gal. was maintained in the case of Filter No. 5 from the time it was started on September 9th, 1908, until November 8th, 1908, when it was reduced to about 17 000 000 gal., which rate was maintained thereafter until the filter was shut down in February, 1909.


I
Supply Raw Water
II
III
IV
V
VI
24
36
18
40"
24
12
84
96"
36"
108
Drain
Effluent
Tanks to be Cylindrical and of Diameters given
12" Gravel over Under drains

Filter No.	Filtering Material Depth M	Filtering Material Size of Particles mm	Rates of Filtration Vertical M. per Day
I	0.30	15-20	45
II	0.35	10-15	45
III	0.40	7-10	45
IV	0.40	4-7	45
V	0.60	Coarse Sand	16
VI	0.90	Fine Sand	2.8

DIAGRAMMATIC SKETCH SHOWING PROPOSED ARRANGEMENTS FOR TESTING "PUECH" SYSTEM OF WATER FILTRATION AT WASHINGTON D.C., U.S.A.

FIG. 6.

In the case of Filter No. 6, it was found impossible to maintain a rate of 100 000 000 gal. for more than a very few days at a time. It was started at about this rate, however, at the beginning of each run and kept as high as possible for the remainder of the time during the

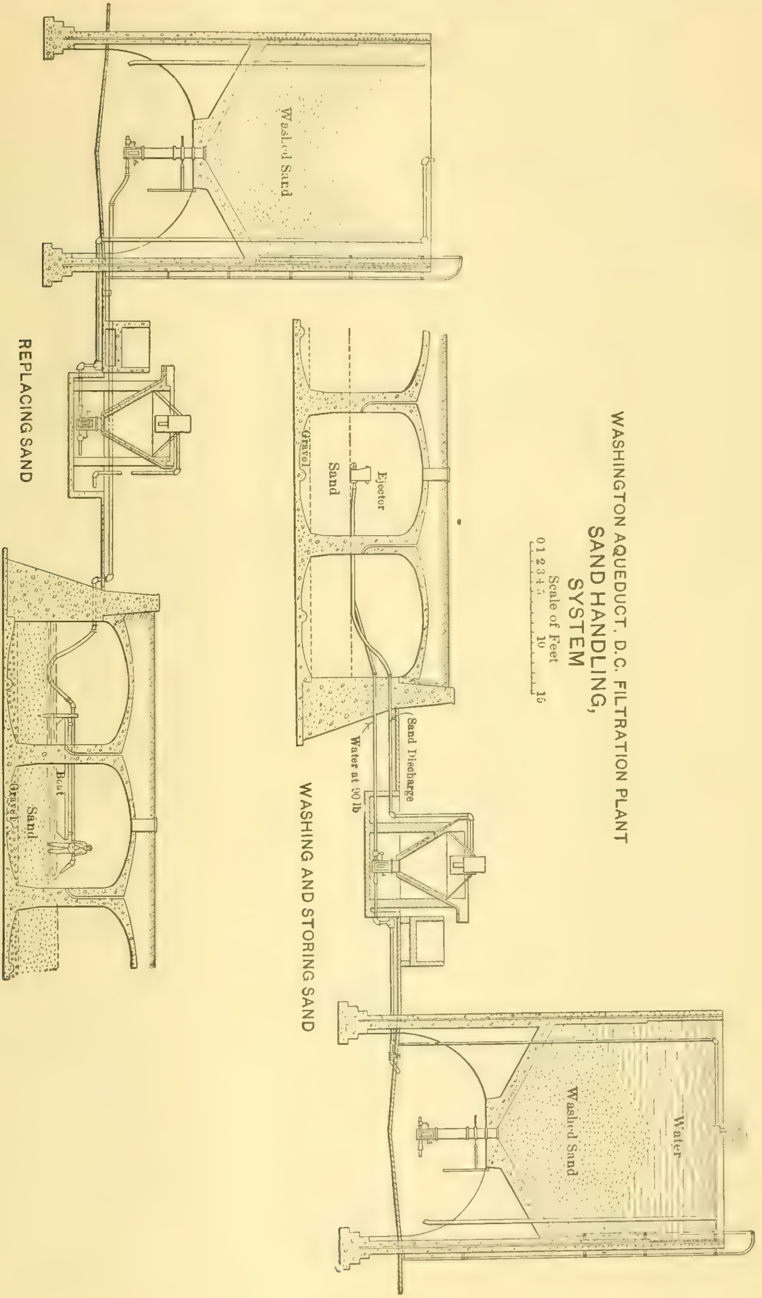

WASHINGTON AQUEDUCT, D.C. FILTRATION PLANT
SAND HANDLING, SYSTEM
Scale of Feet
0 1 2 3 4 5 10 15
REPLACING SAND
Washed Sand
Boat
Gravel
Sand
WASHING AND STORING SAND
Ejector
Sand
Gravel
Sand Discharge
Water at 90 lb
Washed Sand
Water

Fig. 7.

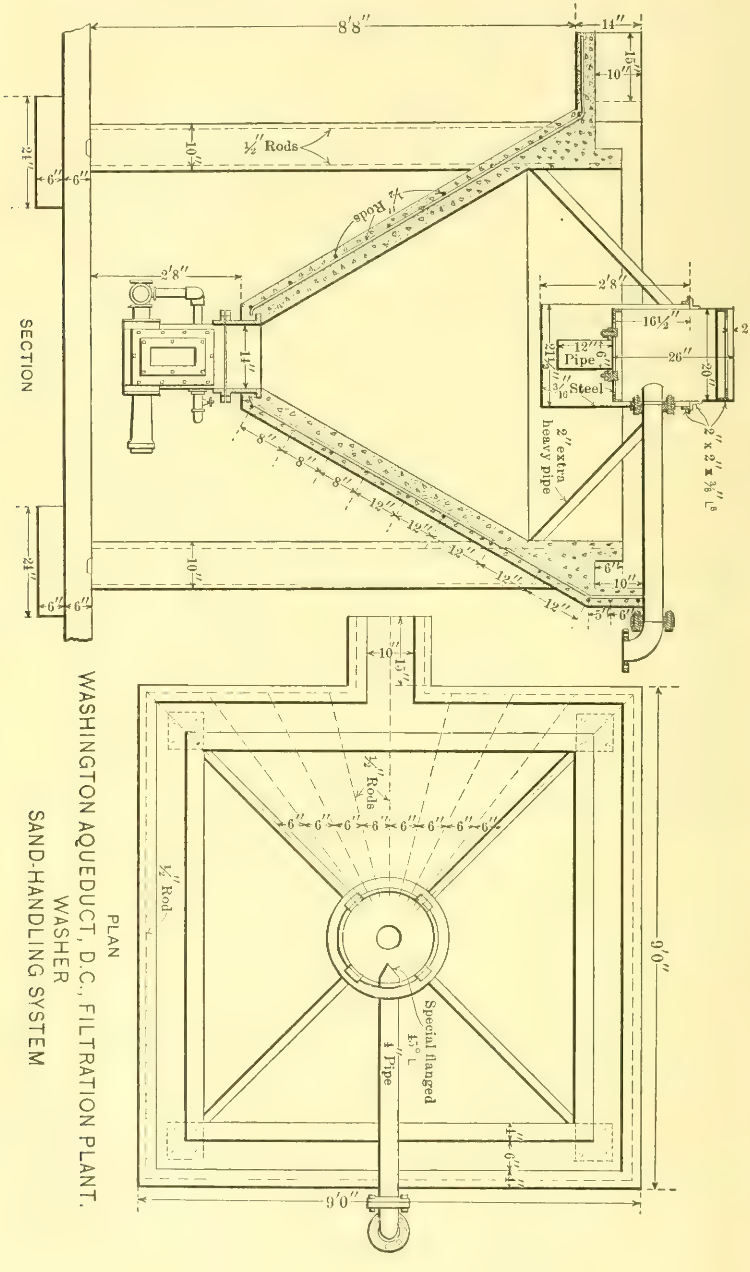


FIG. 8.

WASHINGTON AQUEDUCT, D.C., FILTRATION PLANT.
WASHER
SAND-HANDLING SYSTEM

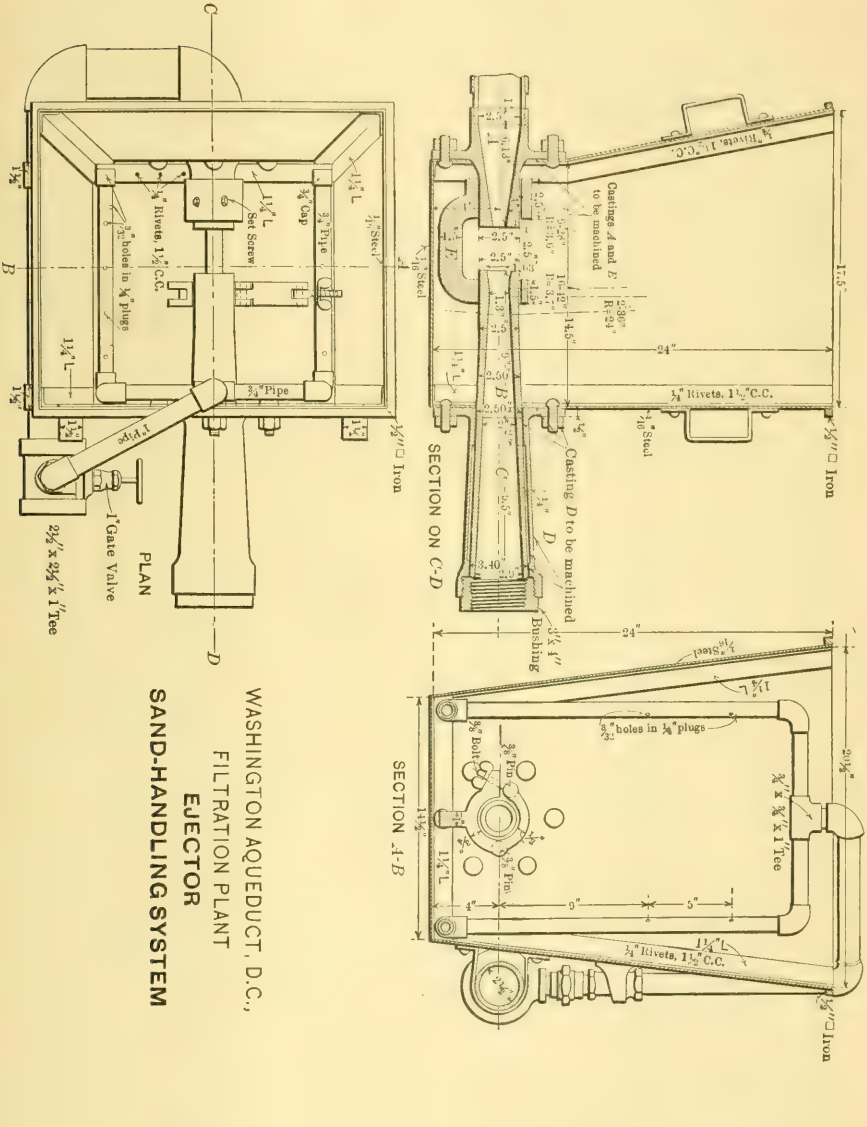

WASHINGTON AQUEDUCT, D.C.,
FILTRATION PLANT
EJECTOR
SAND-HANDLING SYSTEM

TABLE 17.—RECORD OF EXPERIMENTAL FILTER PLANT NO. 1.

Date.	PRELIMINARY FILTER.		FINAL FILTER.		TURBIDITY.			BACTERIA.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
Feb. 8.....	19.40	0.71	3.10	0.17	...	...	..	1 100	2 000	2 500
" 9.....	21.50	0.81	3.11	0.16	...	...	..	200	950	500
" 10.....	20.60	0.95	3.04	0.14	...	...	..	......	......	.....
" 11.....	20.10	1.08	3.03	0.12	12	3	2	600	900	1 300
" 12.....	19.80	1.23	3.02	0.13	14	4	2	650	650	650
" 13.....	19.50	1.38	2.96	0.12	15	6	2	600	600	950
" 14.....	21.20	1.67	3.21	0.11	15	4	2	650	700	800
" 15.....	25.40	2.03	3.90	0.13	12	4	2	600	550	800
" 16.....	25.00	2.23	3.89	0.12	14	3	2	850	550	500
" 17.....	Shut down for changes in size of meter and piping.									
" 18.....	......	....	....	....	...	...	..	1 200	......	650
" 21.....	38.60	1.59	3.93	0.18	20	4	2	1 800	1 100	700
" 22.....	38.00	1.84	3.92	0.15	15	3	2		Holiday.	
" 23.....	42.10	2.36	3.95	0.14	20	5	2	1 600	600	220
" 24.....	47.90	3.04	3.93	0.13	20	6	3		Sunday.	
" 25.....	Shut down to change meter from outlet to inlet.							1 400	800	450
" 27.....	......	2.24	....	0.13	17	6	3	700	550	280
" 28.....	49.80	2.55	3.90	0.13	15	6	3	800	470	230
Mar. 1.....	50.00	2.90	3.93	0.13	15	5	3	650	450	140
" 2.....	50.20	3.21	3.93	0.13	15	5	3	1 000	650	200
" 3.....	38.80	3.09	3.89	0.13	31	8	3		Sunday.	
" 4.....	50.00	3.54	3.93	0.12	35	10	5	1 200	......	.....
" 5.....	50.00	4.01	3.90	0.13	135	39	8	13 000	3 700	600
" 6.....	50.00	4.82	3.90	0.13	135	39	8	18 000	4 500	.....
" 7.....	50.00	5.89	3.90	0.13	102	34	6	24 000	5 000	2 000
" 8.....	50.00	6.58	3.90	0.13	100	25	4	22 000	5 000	1 400
" 9.....	50.00	7.21	3.93	0.13	90	25	4	24 000	4 000	650
" 10.....	50.00	7.52	3.90	0.13	82	22	5		Sunday.	
	Washed.									
" 11.....	50.00	0.84	3.90	0.13	68	19	6	18 000	2 100	350
" 12.....	50.00	0.95	3.96	0.13	46	19	4	11 000	6 000	310
" 13.....	50.00	1.17	3.99	0.13	40	19	4	9 000	4 900	300
" 14.....	50.00	1.53	4.01	0.13	39	17	4	5 500	1 300	130
" 15.....	50.00	2.27	4.05	0.13	35	15	4	6 500	1 500	60
" 16.....	50.00	3.08	4.03	0.13	60	20	4	5 000	1 200	100
" 17.....	50.00	4.26	4.03	0.13	135	35	4		Sunday.	
" 18.....	50.00	5.65	4.00	0.13	170	49	7	9 000	1 200	95
" 19.....	50.00	7.02	4.01	0.13	125	37	6	7 000	600	100
	Washed.									
" 20.....	50.00	1.08	3.98	0.13	102	30	5	4 800	300	75
" 21.....	50.00	1.23	3.98	0.12	125	32	4	8 500	1 000	85
" 22.....	50.00	1.46	4.00	0.13	190	65	4	7 500	1 100	45
" 23.....	50.00	1.76	3.99	0.13	180	65	6	7 500	600	55
" 24.....	50.00	2.11	3.99	0.12	140	52	7		Sunday.	
" 25.....	50.00	2.46	4.00	0.11	88	30	5	4 400	500	85
" 26.....	50.00	2.75	4.00	0.12	62	22	4	3 600	300	65
" 27.....	50.00	3.04	4.08	0.13	47	18	4	2 200	160	60
" 28.....	50.00	3.38	3.94	0.11	35	10	3	1 300	100	55
" 29.....	50.00	3.70	4.00	0.11	26	8	3	700	80	29
" 30.....	50.00	4.42	4.00	0.11	25	6	3	310	70	35
" 31.....	50.00	5.25	3.99	0.11	21	5	2		Sunday.	
Apr. 1.....	50.00	6.14	4.00	0.12	20	5	2	600	25	30
	Washed.									
" 2.....	50.00	2.10	4.00	0.12	24	5	2	270	28	32
" 3.....	50.00	3.00	4.00	0.12	24	5	2	460	26	43

TABLE 17.—(*Continued.*)

Date.	Preliminary filter.		Final filter.		Turbidity.			Bacteria.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
Apr. 4.....	50.00	4.01	4.00	0.12	20	5	2	280	20	26
" 5.....	50.00	5.15	4.00	0.12	20	4	2	450	37	41
	Washed.									
" 6.....	50.00	0.76	3.59	0.12	20	4	2	320	6	34
" 7.....	50.00	0.99	3.47	0.12	20	4	2	Sunday.		
" 8.....	50.00	1.39	4.03	0.14	18	3	2	330	10	20
" 9.....	50.00	2.04	4.01	0.13	18	3	2	140	9	35
" 10.....	50.00	3.03	4.02	0.13	30	2	1	750	43	29
" 11.....	50.00	4.45	4.02	0.14	66	4	1	4 000	900	26
" 12.....	50.00	6.14	4.01	0.13	72	11	2	14 000	1 700	41
	Washed.									
" 13.....	50.00	0.95	4.00	0.14	80	21	2	13 000	1 300	70
" 14.....	50.00	1.18	4.00	0.13	77	25	3	Sunday.		
" 15.....	50.00	1.57	4.00	0.14	62	21	3	7 000	380	55
" 16.....	50.00	2.33	4.00	0.15	47	20	3	3 600	160	33
" 17.....	50.00	3.33	4.00	0.15	39	15	2	1 600	70	39
" 18.....	50.00	4.81	4.00	0.16	30	10	2	1 810	130	34
" 19.....	50.00	6.29	3.99	0.16	25	7	2	790	50	32
	Washed.									
" 20.....	50.00	0.93	4.01	0.16	20	5	2	540	24	28
" 21.....	50.00	1.36	3.97	0.16	20	3	2	Sunday.		
" 22.....	50.00	2.22	4.02	0.16	18	2	1	235	15	28
" 23.....	50.00	3.33	3.99	0.14	15	2	1	170	14	16
" 24.....	50.00	4.78	3.97	0.15	19	1	1	150	32	14
" 25.....	50.00	6.43	3.90	0.15	34	1	1	700	20	18
	Washed.									
" 26.....	50.00	0.97	3.97	0.14	46	2	1	1 200	16	16
" 27.....	50.00	2.37	4.00	0.14	52	3	1	1 700	25	17
" 28.....	50.00	5.33	3.99	0.14	45	4	1	Sunday.		
	Washed.									
" 29.....	50.00	0.81	3.99	0.14	44	5	1	600	16	17
" 30.....	50.00	1.75	3.99	0.14	39	6	1	550	27	12
May 1.....	50.00	0.80	3.99	0.14	31	5	1	500	24	11
	Washed.									
" 2.....	50.00	1.13	4.00	0.14	24	4	1	500	12	16
" 3.....	50.00	2.09	4.00	0.14	19	3	1	280	30	25
" 4.....	50.00	3.80	4.00	0.14	16	2	1	400	20	12
" 5.....	50.00	5.38	4.00	0.14	15	1	1	Sunday.		
	Washed.									
" 6.....	50.00	0.91	3.90	0.14	13	1	1	390	50	40
" 7.....	50.00	1.56	3.90	0.14	12	1	1	190	19	30
" 8.....	50.00	2.25	3.99	0.14	10	1	1	......	......	.....
" 9.....	50.00	3.37	4.00	0.14	10	1	1	390	21	38
" 10.....	50.00	5.16	4.00	0.14	10	1	1	300	14	13
	Washed.									
" 11.....	50.00	1.03	4.00	0.14	12	1	1	390	13	12
" 12.....	50.00	1.89	4.00	0.14	17	1	1	Sunday.		
" 13.....	50.00	3.82	4.00	0.14	35	2	1	600	33	15
" 14.....	50.00	6.31	4.00	0.14	39	3	1	500	27	7
	Washed.									
" 15.....	50.00	0.85	4.00	0.14	17	2	1	500	20	29
" 16.....	50.00	1.42	3.99	0.14	24	2	1	290	19	40
" 17.....	50.00	2.47	3.99	0.14	18	2	1	260	19	16
" 18.....	50.00	4.31	4.00	0.13	15	1	1	190	16	20
	Washed.									
" 19.....	50.00	0.83	3.99	0.13	12	1	1	Sunday.		

TABLE 17.—(*Continued.*)

Date.	PRELIMINARY FILTER.		FINAL FILTER.		TURBIDITY.			BACTERIA.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
May 20.....	50.00	1.66	4.00	0.13	12	1	1	260	17	41
“ 21.....	50.00 Washed.	3.83	4.00	0.13	16	1	1	260	26	25
“ 22.....	50.00	0.82	3.99	0.13	20	1	1	280	16	19
“ 23.....	50.00	1.64	4.00	0.13	15	1	1	130	20	22
“ 24.....	50.00 Washed.	3.85	4.00	0.13	15	1	1	170	17	32
“ 25.....	50.00	0.84	4.00	0.13	15	1	1	340	25	55
“ 26.....	50.00	1.67	3.99	0.13	18	1	1	Sunday.		
“ 27.....	50.00 Washed.	3.03	4.00	0.13	13	1	1	210	10	40
“ 28.....	50.00	0.87	4.01	0.13	16	1	1	260	26	55
“ 29.....	50.00	1.43	4.01	0.13	16	1	1	500	19	50
“ 30.....	50.00	2.55	4.00	0.13	14	1	1	Holiday.		
“ 31.....	50.00	4.19	4.00	0.13	17	1	1	380	22	50
June 1.....	50.00 Washed.	6.26	3.99	0.13	15	1	1	900	27	50
“ 2.....	50.00	0.78	3.98	0.13	17	1	1	Sunday.		
“ 3.....	50.00	1.19	4.00	0.13	24	1	1	550	41	50
“ 4.....	50.00	2.15	4.00	0.13	37	2	1	6 500	150	60
“ 5.....	50.00	3.67	4.01	0.13	65	4	1	3 200	150	46
“ 6.....	50.00 Washed.	6.06	4.00	0.14	77	12	1	1 500	60	27
“ 7.....	50.00	0.86	4.00	0.14	64	19	1	2 100	68	45
“ 8.....	50.00	1.41	4.00	0.14	46	16	1	600	35	44
“ 9.....	50.00	2.62	4.01	0.14	44	12	1	Sunday.		
“ 10.....	50.00 Washed.	4.79	4.00	0.14	36	8	1	240	31	35
“ 11.....	50.00	0.77	4.00	0.14	30	6	1	280	47	47
“ 12.....	50.00	1.20	4.01	0.14	34	6	1	330	70	55
“ 13.....	50.00	2.42	4.00	0.14	35	8	1	480	43	75
“ 14.....	50.00 Washed.	4.44	4.00	0.15	31	7	1	440	55	45
“ 15.....	50.00	0.80	3.99	0.15	32	6	1	420	17	34
“ 16.....	50.00	1.15	4.00	0.15	26	5	1	Sunday.		
“ 17.....	50.00	2.15	3.99	0.14	26	5	1	340	55	37
“ 18.....	50.00 Washed.	4.36	4.00	0.14	31	6	1	440	14	140
“ 19.....	50.00	0.79	4.01	0.15	37	8	1	500	70	24
“ 20.....	50.00	1.19	4.00	0.15	30	7	1	330	49	27
“ 21.....	50.00	2.65	3.98	0.14	25	5	1	170	30	18
“ 22.....	50.00 Washed.	5.58	4.00	0.14	20	4	1	100	18	13
“ 23.....	50.00	0.85	3.62	0.13	26	3	1	Sunday.		
“ 24.....	50.00	2.02	3.99	0.13	140	11	1	1 700	27	36
“ 25.....	50.00 Washed.	4.77	3.99	0.13	130	26	1	400	70	23
“ 26.....	50.00	0.73	4.01	0.13	82	27	1	750	200	41
“ 27.....	50.00	1.17	4.01	0.13	65	18	1	......	......	.....
“ 28.....	50.00 Washed.	3.10	3.99	0.13	47	16	1	......	20	.....
“ 29.....	50.00	0.67	3.99	0.13	37	7	1	220	35	29
“ 30.....	50.00	1.02	4.00	0.13	30	6	1	Sunday.		
July 1.....	50.00 Washed.	2.70	3.99	0.13	30	6	1	400	46	3

TABLE 17.—(*Continued.*)

Date.	PRELIMINARY FILTER.		FINAL FILTER.		TURBIDITY.			BACTERIA.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
July 2......	50.00	0.69	4.00	0.13	32	7	1	180	80	38
“ 3......	50.00	1.21	3.99	0.13	36	8	1	350	70	90
“ 4......	50.00	3.40	3.99	0.13	44	10	1		Holiday.	
	Washed.									
“ 5......	50.00	0.77	3.99	0.13	44	11	1	550	180	34
“ 6......	50.00	1.19	4.01	0.13	39	10	1	250	60	26
“ 7......	50.00	3.72	3.99	0.13	34	8	1		Sunday.	
	Washed.									
“ 8......	50.00	0.78	3.97	0.13	25	5	1	220	31	21
“ 9......	50.00	1.27	3.98	0.13	22	4	1	50	10	9
“ 10......	50.00	3.11	4.00	0.13	47	9	1		Lost.	
	Washed.									
“ 11......	50.00	0.83	3.99	0.13	90	19	1	150	19	8
“ 12......	50.00	1.47	3.99	0.13	97	25	1	300	40	23
“ 13......	50.00	3.61	4.00	0.13	90	29	1	220	47	16
	Washed.									
“ 14......	50.00	0.84	3.99	0.13	90	30	1		Sunday.	
“ 15......	50.00	1.30	4.00	0.13	95	30	1	375	55	21
“ 16......	50.00	2.72	3.99	0.14	120	35	1	Lost.	90	13
“ 17......	50.00	5.08	3.99	0.14	85	32	1	270	27	11
	Washed.									
“ 18......	50.00	0.85	3.99	0.14	56	22	1	1 675	70	50
“ 19......	50.00	1.43	4.00	0.14	41	12	1	450	95	22
“ 20......	50.00	3.23	3.99	0.14	62	19	1	300	38	11
	Washed.									
“ 21......	50.00	0.80	3.99	0.14	62	21	1		Sunday.	
“ 22......	50.00	1.06	3.98	0.14	80	26	1	1 400	150	7
“ 23......	50.00	2.18	3.99	0.14	105	30	1	3 700	Lost.	11
“ 24......	50.00	4.95	3.98	0.15	95	30	1	770	“	22
	Washed.									
“ 25......	50.00	0.84	3.98	0.15	77	22	1	250	33	11
“ 26......	50.00	1.22	3.98	0.15	67	19	1	140	100	4
“ 27......	50.00	2.36	4.00	0.16	54	15	1	300	95	7
“ 28......	50.00	4.74	3.98	0.16	46	12	1		Sunday.	
	Washed.									
“ 29......	50.00	0.83	3.99	0.17	36	10	1	470	110	18
“ 30......	50.00	1.02	4.00	0.17	29	7	1		Plates lost.	
“ 31......	50.00	1.66	4.00	0.17	21	5	1		“ “	
Aug. 1......	48.20	2.95	4.00	0.17	16	4	1		“ “	
“ 2......	46.40	4.96	4.00	0.17	15	2	1	130	42	13
	Washed.									
“ 3......	42.60	0.79	4.00	0.17	16	1	1	120	4	16
“ 4......	49.10	0.91	4.00	0.17	21	1	1		Sunday.	
“ 5......	49.10	1.59	4.00	0.17	29	1	1	230	160	11
“ 6......	48.20	3.16	4.00	0.17	34	2	1	85	200	12
“ 7......	45.60	5.65	3.99	0.17	21	2	1	200	Lost.	4
	Washed.									
“ 8......	50.00	0.80	3.99	0.17	19	2	1	100	70	11
“ 9......	49.10	0.94	4.00	0.17	16	1	1	75	44	9
“ 10......	48.20	1.51	4.00	0.17	24	1	1	60	13	6
“ 11......	48.20	3.32	4.00	0.17	62	3	1		Sunday.	
	Washed.									
“ 12......	41.90	0.83	3.99	0.17	120	14	1	620	110	5
“ 13......	49.10	1.14	3.99	0.17	107	29	1	820	53	36
“ 14......	49.10	1.72	4.00	0.18	82	30	1	850	160	110
“ 15......	48.20	3.30	4.00	0.18	65	22	1	150	37	4
	Washed.									

TABLE 17.—(*Continued.*)

Date.	PRELIMINARY FILTER.		FINAL FILTER.		TURBIDITY.			BACTERIA.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
Aug. 16......	46.40	0.84	4.00	0.19	45	15	1	270	110	13
" 17......	48.20	1.05	4.00	0.19	35	10	1	340	110	6
" 18......	50.00	1.54	4.00	0.19	21	5	1		Sunday.	
" 19......	49.10	2.29	4.00	0.19	18	4	1	180	85	13
" 20......	49.10	3.74	3.99	0.19	20	2	1	210	85	8
	Washed.									
" 21......	44.10	1.01	3.98	0.19	20	2	1	1 300	115	9
" 22......	45.60	1.86	4.00	0.19	27	2	1	3 800	265	1
" 23......	47.30	4.08	3.99	0.19	49	2	1	2 500	70	13
	Washed.									
" 24......	41.30	1.29	3.97	0.19	36	6	1	3 900	46	6
" 25......	44.10	2.11	3.98	0.20	34	7	1		Sunday.	
" 26......	48.20	3.42	3.99	0.20	21	5	1	700	140	0
" 27......	48.20	5.10	4.00	0.20	19	4	1	470	100	4
	Washed.									
" 28......	46.40	1.28	4.00	0.20	18	3	1	500	49	3
" 29......	41.90	1.90	4.02	0.20	17	2	1	360	80	0
" 30......	45.60	3.23	4.00	0.20	15	1	1	320	190	1
" 31......	46.40	4.57	4.00	0.20	13	1	1	200	20	3
Sept. 1......	50.00	5.17	3.65	0.20	14	1	1		Sunday.	
" 2......	48.20	5.97	4.00	0.20	12	1	1		Holiday.	
	Washed.									
" 3......	47.30	1.13	4.00	0.20	12	1	1	300	9	1
" 4......	48.20	2.01	4.00	0.20	16	1	1	600	60	2
" 5......	46.40	5.41	3.67	0.20	34	1	0	360	72	....
	Washed.									
" 6......	40.60	1.42	3.98	0.20	160	12	0	15 000	140	0
" 7......	42.60	5.19	3.99	0.20	64	18	1	2 000	130	1
	Washed.									
" 8......	42.60	1.25	4.00	0.20	56	18	1		Sunday.	
" 9......	46.40	3.07	4.00	0.22	59	18	1	220	80	4
	Washed.									
" 10......	45.60	1.02	3.99	0.23	57	16	1	18 000	57	8
" 11......	48.20	2.36	4.00	0.23	65	18	1	2 700	90	1
	Washed.									
" 12......	44.10	1.14	3.99	0.24	72	18	1	1 000	47	4
" 13......	46.40	3.61	3.99	0.25	87	20	1	2 300	77	5
	Washed.									
" 14......	38.20	1.42	3.97	0.26	72	19	1	2 400	80	5
" 15......	45.60	4.27	4.00	0.27	65	18	1		Sunday.	
	Washed.									
" 16......	40.00	1.06	3.99	0.28	65	18	1	Lost.	22	Lost.
" 17......	46.40	2.48	4.01	0.28	52	16	1	420	75	1
	Washed.									
" 18......	46.40	1.11	4.00	0.28	60	13	1	900	37	3
" 19......	46.40	2.76	4.00	0.28	85	16	1	2 000	186	0
	Washed.									
" 20......	44.10	1.12	4.00	0.31	100	19	1	4 200	110	7
" 21......	48.20	2.07	3.99	0.33	120	24	1	1 100	110	3
	Washed.									
" 22......	44.10	1.30	3.67	0.34	137	29	1		Sunday.	
" 23......	45.60	3.79	3.99	0.39	112	25	1	2 400	50	2
	Washed.									
" 24......	45.60	1.15	3.97	0.40	100	25	1	4 000	69	4
" 25......	48.20	2.06	4.00	0.42	432	53	1	56 000	680	6
" 26......	Stopped, unable to wash preliminary.									

TABLE 17.—(*Continued.*)

Date.	Preliminary filter.		Final filter.		Turbidity.			Bacteria.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
Sept. 28.....	50.00	1.74	4.00	0.71	127	35	1	......	......	37
	Washed.									
" 29.....	44.10	2.85	3.99	0.82	105	31	1		Sunday.	
" 30.....	44.90	3.78	3.97	1.04	115	32	1	Lost.	Lost.	160
	Washed.									
Oct. 1.....	44.10	1.20	3.98	1.34	82	26	1	600	180	55
" 2.....	49.10	3.22	3.97	1.54	65	19	1	4 400	120	5
	Washed.									
" 3.....	44.10	1.31	3.97	1.56	59	17	1	900	55	10
" 4.....	49.10	2.97	3.97	1.65	55	15	1	850	60	6
	Washed.									
" 5.....	44.90	1.31	3.98	1.75	59	16	1	2 000	110	38
" 6.....	46.40	3.65	3.99	1.89	59	17	1		Sunday.	
	Washed.									
" 7.....	44.90	1.34	3.98	1.99	52	13	1	1 250	70	15
" 8.....	49.10	3.49	3.98	2.17	54	13	1	11 000	65	6
	Washed.									
" 9.....	44.10	1.20	3.97	2.33	51	13	1	2 000	85	4
" 10.....	49.10	2.22	3.98	2.55	50	12	1	800	36	10
" 11.....	46.40	4.59	4.00	2.51	47	11	1	2 000	57	10
" 12.....	Shut off to remove sand in preliminary filter in order to clean out the underdrains.									
Nov. 5.....	50.00	1.38	3.97	3.49	185	50	1	......	......	.....
" 6.....	48.20	3.25	3.98	3.79	170	52	1	5 000	1 500	240
	Washed.									
" 7.....	45.60	1.18	3.98	4.05	100	35	1	14 000	1 000	220
" 8.....	48.20	4.08	3.99	4.37	95	32	1	1 900	270	160
" 9.....	42.00	6.58	3.98	4.39	80	27	1	4 000	500	190
" 10.....	Shut down for scraping. Removed 266 000 cu. cm. of sand.									
" 12.....	50.00	0.98	3.99	0.25	40	10	1	......	......	.....
" 13.....	50.00	1.51	4.00	0.22	36	8	1	1 600	750	85
" 14.....	48.20	2.60	4.00	0.21	42	11	1	2 700	700	210
" 15.....	47.30	3.80	4.00	0.20	35	9	1	1 800	350	180
" 16.....	47.30	4.87	4.00	0.19	26	5	1	1 100	200	34
" 17.....	50.00	5.75	4.00	0.19	20	4	1		Sunday.	
" 18.....	50.00	6.41	4.00	0.19	17	3	1	1 600	290	55
	Washed.									
" 19.....	48.20	1.06	3.99	0.20	16	2	1	1 300	480	60
" 20.....	48.20	2.05	3.99	0.20	45	3	1	6 500	3 700	800
" 21.....	48.20	3.48	3.99	0.20	52	9	1	9 900	4 000	300
" 22.....	47.30	4.85	3.99	0.20	65	17	1	10 000	1 000	380
" 23.....	48.20	6.11	3.99	0.20	49	15	1	18 000	1 000	320
	Washed.									
" 24.....	46.40	3.74	3.98	0.20	134	24	1		Sunday.	
" 25.....	Shut down for fear of washing preliminary with such muddy water.									
" 29.....	50.00	1.55	4.00	0.21	80	25	1	......	......	.....
" 30.....	47.30	3.14	3.98	0.22	54	16	1	3 800	950	160
Dec. 1.....	47.30	4.48	3.98	0.23	37	10	1		Sunday.	
" 2.....	47.30	5.63	3.98	0.25	30	6	1	2 900	550	90
	Washed.									
" 3.....	46.40	0.98	3.99	0.25	29	6	1	2 900	480	75
" 4.....	50.00	1.15	3.99	0.26	20	4	1	2 000	270	70
" 5.....	50.00	1.48	4.00	0.25	18	3	1	1 100	270	50
" 6.....	48.20	2.04	3.63	0.25	16	2	1	3 000	......	.....

TABLE 17.—(*Continued.*)

Date.	PRELIMINARY FILTER.		FINAL FILTER.		TURBIDITY.			BACTERIA.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
Dec. 7.....	48.20	2.80	4.00	0.26	14	1	1	2 400	190	10
“ 8.....	50.00	3.40	3.72	0.27	12	1	1		Sunday.	
“ 9.....	49.10	3.93	4.00	0.27	11	1	1	1 200	170	7
“ 10.....	49.10	4.50	4.00	0.27	12	1	1	800	90	55
“ 11.....	48.20	5.52	4.00	0.27	255	44	1	6 500	......	.....
“ 12.....	Shut down 12/11 at 6 P. M., turbidity too high to wash.									
“ 15.....	......	....	....	....	.....	.....	....		Sunday.	
“ 16.....	50.00	4.02	3.99	0.28	90	35	2	......	......	.....
	Washed.									
“ 17.....	40.00	1.90	3.97	0.30	70	25	2	21 000	10 000	1 200
	Washed.									
“ 18.....	44.10	1.08	3.97	0.31	49	15	2	6 500	4 200	800
“ 19.....	48.20	1.88	3.98	0.31	39	10	1	Lost.	Lost.	Lost.
“ 20.....	46.40	4.77	3.99	0.31	42	13	1	“	“	“
“ 21.....	46.40	6.68	3.99	0.32	26	6	1	“	“	“
	Washed.									
“ 22.....	49.10	1.14	3.99	0.32	20	4	1		Sunday.	
“ 23.....	49.10	2.17	4.00	0.31	34	7	1	1 400	300	100
“ 24.....	49.10	3.76	4.00	0.31	195	56	1	9 000	950	70
“ 25.....	Shut down 12/24 at 9 P. M., turbidity too high to wash.								Holiday.	
“ 30.....	50.00	2.61	3.97	0.33	56	19	2	......	......	.....
“ 31.....	44.80	5.57	3.98	0.36	39	12	1	......	......	.....
	Washed.									
1908.										
Jan. 1.....	46.40	1.30	3.98	0.36	31	6	1		Holiday.	
“ 2.....	48.20	3.36	4.00	0.36	39	9	1	......	......	.....
“ 3.....	47.30	4.95	3.99	0.35	36	9	1	3 100	490	90
“ 4.....	50.00	5.28	3.99	0.35	32	7	1	2 400	240	43
“ 5.....	49.10	6.26	4.00	0.35	26	5	1		Sunday.	
	Washed.									
“ 6.....	49.10	0.99	3.98	0.35	20	4	1	600	200	37
“ 7.....	50.00	1.15	4.00	0.35	20	4	1	1 100	150	47
“ 8.....	50.00	1.41	4.00	0.35	22	4	1	1 900	160	30
“ 9	49.10	1.92	4.00	0.35	45	11	1	13 000	1 300	70
“ 10.....	49.10	2.56	4.00	0.36	70	25	1	10 000	3 500	170
“ 11.....	50.00	3.17	3.99	0.37	56	18	1	16 000	4 000	240
“ 12.....	49.10	3.73	4.00	0.37	40	10	1		Sunday.	
“ 13.....	50.00	4.14	4.00	0.37	110	45	2	8 500	1 200	340
“ 14.....	49.10	4.65	3.99	0.38	210	95	3	16 000	3 900	500
“ 15.....	49.10	5.23	3.99	0.41	325	190	12	24 000	7 000	550
“ 16.....	50.00	5.75	3.99	0.43	360	210	37	28 000	8 500	1 200
“ 17.....	49.10	6.34	4.00	0.45	242	122	24	65 000	15 000	1 700
“ 18.....	......	....	....	....	.....	.....	....	......	......	.....
“ 19.....	50.00	1.17	4.00	0.46	117	40	12		Sunday	
“ 20.....	50.00	1.38	4.00	0.46	72	31	6	1 600	1 800	320
“ 21.....	50.00	1.68	3.57	0.37	55	20	4	5 000	450	.....
“ 22.....	49.10	2.04	4.00	0.44	49	17	3	3 600	600	100
“ 23.....	50.00	2.47	3.24	0.33	40	12	3	1 800	290	130
“ 24.....	49.10	3.03	3.00	0.34	40	11	2	2 300	270	65
“ 25.....	50.00	3.61	3.00	0.35	39	10	2	1 100	180	60
“ 26.....	49.10	4.18	2.99	0.35	32	7	2		Sunday.	
“ 27.....	50.00	4.81	3.00	0.35	32	7	2	300	40	24
“ 28.....	48.20	5.45	2.99	0.35	45	12	2	1 200	90	31
“ 29.....	49.10	6.01	2.99	0.35	60	21	2	1 000	230	50
“ 30.....	49.10	6.62	2.99	0.36	57	22	2	1 400	170	43
	Washed.									
“ 31.....	50.00	1.30	2.99	0.36	42	15	2	1 100	190	23

TABLE 17.—(*Continued.*)

Date.	Preliminary filter.		Final filter.		Turbidity.			Bacteria.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1908.										
Feb. 1.....	50.00	1.51	2.99	0.37	39	11	2	750	40	31
" 2.....	50.00	1.78	3.00	0.37	27	7	2		Sunday.	
" 3.....	49.10	2.13	3.00	0.37	29	6	2	1 300	200	7
" 4.....	50.00	2.69	3.00	0.37	25	5	1	600	160	18
" 5.....	49.10	3.31	2.99	0.37	24	5	1	750	140	41
" 6.....	50.00	3.89	2.99	0.37	20	4	1	2 000	180	29
" 7.....	48.20	4.50	2.99	0.37	17	3	1	......	38	15
" 8.....	49.10	5.11	2.99	0.37	15	3	1	900	95	24
" 9.....	49.10	5.65	3.00	0.38	14	3	1		Sunday.	
" 10.....	49.10	6.43	2.99	0.38	11	3	1	850	85	21
" 11.....	50.00	6.90	3.00	0.38	10	3	1	1 000	70	20
	Washed.									
" 12.....	49.10	1.29	2.99	0.38	8	2	1	750	20	16
" 13.....	50.00	1.50	2.99	0.39	9	2	1	700	40	11
" 14.....	50.00	1.80	2.99	0.39	9	2	1	1 200	39	7
" 15.....	49.10	2.35	3.00	0.39	61	13	1	5 500	600	7
" 16.....	49.10	3.28	2.99	0.39	80	30	2		Sunday.	
" 17.....	48.20	4.85	2.99	0.39	80	29	3	33 000	3 800	130
" 18.....	47.30	6.39	2.99	0.39	130	44	3	......	2 600	160
" 19.....	45.50	7.32	2.98	0.40	320	143	6	28 000	6 000	180
	Washed.									
" 22.....	50.00	1.40	3.00	0.41	85	30	5		Holiday.	
" 23.....	50.00	1.77	3.00	0.41	60	21	4		Sunday.	
" 24.....	49.10	2.25	2.99	0.41	46	14	3	3 600	2 800	90
" 25.....	50.00	2.61	3.00	0.41	31	7	2	2 300	140	47
" 26.....	50.00	3.06	3.00	0.41	30	6	2	3 800	140	45
" 27.....	48.20	3.65	2.99	0.41	30	5	1	1 300	100	22
" 28.....	50.00	4.24	3.00	0.41	37	6	1	1 400	100	40
" 29.....	48.20	5.28	2.99	0.41	123	52	2	13 500	420	40
	Washed.									
Mar. 1.....	44.60	1.56	2.99	0.42	97	39	5		Sunday.	
" 2.....	48.20	2.90	2.99	0.42	82	30	4	8 000	320	60
" 3.....	46.40	4.69	2.98	0.42	87	33	4	11 000	750	30
" 4.....	47.30	6.13	2.99	0.42	67	24	3	6 000	290	34
" 5.....	48.20	7.31	2.99	0.42	59	19	3	4 400	220	41
	Washed.									
" 6.....	49.10	1.53	2.99	0.42	72	24	2	7 000	170	41
" 7.....	50.00	1.95	3.00	0.43	82	30	2	9 500	210	34
" 8.....	49.10	2.62	2.99	0.43	92	37	3		Sunday.	
" 9.....	50.00	3.19	3.00	0.43	125	56	4	11 000	700	65
" 10.....	Preliminary filter discontinued and the Puech system started.									

TABLE 17.—Record of Experimental Filter, Puech System.—(*Continued.*)

Date.	Puech system:					Final filter.		Turbidity.			Bacteria.		
	Rates, millions of gallons per acre daily.					Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1908.													
Mar. 11...	265	170	90	53	18	2.99	0.53	155	80	7	6 500	8 500	490
" 12...	265	170	90	53	18	2.99	0.60	135	70	7	5 900	6 000	360
" 13...	265	170	90	53	18	3.00	0.60	122	52	6	1 900	1 700	140
" 14...	265	170	90	53	18	3.00	0.61	97	40	5	1 800	1 600	130
" 15...	265	170	90	53	18	2.99	0.64	77	31	4		Sunday.	
" 16...	265	170	90	53	18	3.00	0.69	65	26	3	1 400	1 200	50
" 17...	241	155	82	48	16	2.99	0.71	59	19	3	900	200	45
" 18...	252	162	86	50	17	2.99	0.75	67	22	2	1 000	700	33
" 19...	241	155	82	48	16	2.99	0.78	60	21	2	......	800	44
" 20...	294	189	100	59	20	2.99	0.85	57	18	2	1 300	650	37
" 21...	279	179	95	56	19	2.99	0.92	67	21	2	800	600	34
" 22...	265	170	90	53	18	2.99	0.99	80	27	2		Sunday.	
" 23...	265	170	90	53	18	2.99	1.06	90	32	2	4 600	1 300	33
" 24...	265	170	90	53	18	2.99	1.12	82	34	3	2 500	950	38
" 25...	265	170	90	53	18	2.99	1.18	67	27	3	1 600	....	30
" 26...	265	170	90	53	18	2.99	1.22	60	20	3	550	400	24
" 27...	265	170	90	53	18	3.00	1.23	59	18	2	950	360	28
" 28...	265	170	90	53	18	3.00	1.25	51	14	2	650	230	18
" 29...	265	170	90	53	18	2.99	1.28	31	6	2		Sunday.	
" 30...	265	170	90	53	18	2.99	1.36	30	5	1	500	160	25
" 31...	265	170	90	53	18	2.99	1.43	39	7	1	750	140	26
April 1...	265	170	90	53	18	3.00	1.48	44	9	1	750	60	41
" 2...	265	170	90	53	18	2.99	1.56	42	9	1	1 100	140	26
" 3...	318	204	108	64	22	2.99	1.63	41	8	1	1 500	47	11
" 4...	294	189	100	59	20	2.99	1.70	54	13	1	700	80	35
" 5...	279	179	95	56	19	3.00	1.73	50	13	1		Sunday.	
" 6...	279	179	95	56	19	2.99	1.76	41	9	1	440	65	17
" 7...	265	170	90	53	18	3.00	1.78	35	6	1	650	65	34
" 8...	265	170	90	53	18	3.00	1.79	39	6	1	550	44	10
" 9...	265	170	90	53	18	3.00	1.79	40	6	1	390	30	25
" 10...	265	170	90	53	18	3.00	1.77	40	6	1	500	27	16
" 11...	265	170	90	53	18	3.00	1.78	45	7	1	430	28	28
" 12...	265	170	90	53	18	2.99	1.80	52	11	1		Sunday.	
" 13...	265	170	90	53	18	....	1.81	50	10	1	490	17	26
" 14...	Shut down on account of losing water when aqueduct was drained; also cleaned coarse sand filter. Started April 22d.												
" 23...	241	155	82	48	16	....	1.82	29	4	1	140	600	38
" 24...	241	155	82	48	16	3.00	1.87	21	3	1	200	1 000	13
" 25...	241	155	82	48	16	2.99	1.95	20	3	1	85	180	25
" 26...	252	162	86	50	17	3.00	1.95	24	3	1		Sunday.	
" 27...	241	155	82	48	16	3.00	1.93	18	2	1	95	35	23
" 28...	241	155	82	48	16	3.00	1.96	20	2	1	70	24	18
" 29...	241	155	82	48	16	2.99	1.97	24	3	1	110	21	24
" 30...	241	155	82	48	16	2.99	2.03	21	2	1	70	25	6
May 1...	241	155	82	48	16	3.00	2.07	32	4	1	130	20	18
" 2...	241	155	82	48	16	2.99	2.12	26	3	1	140	16	12
" 3...	241	155	82	48	16	2.99	2.17	22	3	1		Sunday.	
" 4...	241	155	82	48	16	3.00	2.19	19	2	1	85	30	17
" 5...	241	155	82	48	16	3.00	2.20	18	2	1	130	33	9
" 6...	241	155	82	48	16	2.99	2.23	18	2	1	230	55	6
" 7...	252	162	86	50	17	3.00	2.24	19	2	1	160	75	10
" 8...	241	155	82	48	16	3.00	2.25	19	2	1	375	55	8
" 9...	318	204	108	64	22	2.99	2.29	18	2	1	1 200	12	9
" 10...	318	204	108	64	22	2.99	2.30	30	3	1		Sunday.	
" 11...	265	170	90	53	18	2.99	2.33	60	10	1	2 800	130	11
" 12...	252	162	86	50	17	2.99	2.39	70	15	1	2 900	135	9

TABLE 17.—(*Continued.*)

Date.	PUECH SYSTEM: Rates, millions of gallons per acre daily.					FINAL FILTER.		TURBIDITY.			BACTERIA.		
						Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1908.													
May 13...	241	155	82	48	16	3.00	2.41	66	14	1	1 800	110	16
" 14...	265	170	90	53	18	3.00	2.38	45	7	1	2 700	65	18
" 15...	252	162	86	50	17	3.00	2.41	39	5	1	950	45	14
" 16...	241	155	82	48	16	3.00	2.41	49	7	1	800	32	10
" 17...	241	155	82	48	16	3.01	2.34	46	7	1		Sunday.	
" 18...	241	155	82	48	16	3.00	2.31	31	4	1	700	26	6
" 19...	252	162	86	50	17	3.00	2.26	36	4	1	375	28	17
" 20...	252	162	86	50	17	3.00	2.20	41	5	1	425	38	11
" 21...	344	221	117	69	23	3.00	2.18	30	3	1	300	25	9
" 22...	241	155	82	48	16	3.01	2.17	53	7	1	950	220	18
" 23...	265	170	90	53	18	2.99	2.25	127	33	1	2 400	600	21
" 24...	331	212	112	66	22	3.00	2.19	110	39	3		Sunday.	
" 25...	318	204	108	64	22	3.01	2.02	90	25	3	600	300	40
" 26...	279	179	95	56	19	3.02	1.87	135	45	3	3 200	110	34
" 27...	265	170	90	53	18	3.01	1.63	110	39	3	1 450	320	45
" 28...	252	162	86	50	17	3.01	1.41	90	27	3	1 000	95	28
" 29...	252	162	86	50	17	3.01	1.24	70	17	3	1 100	150	26
" 30...	252	162	86	50	17	3.01	1.07	50	9	2		Holiday.	
" 31...	241	155	82	48	16	3.01	1.03	34	4	2		Sunday.	
June 1...	252	162	86	50	17	3.00	0.83	35	4	1	....	....	..
" 2...	241	155	82	48	16	3.00	0.74	39	5	1	....	....	..
" 3...	252	162	86	50	17	3.00	0.68	35	4	1	....	....	..
" 4...	241	155	82	48	16	3.00	0.63	30	3	1	....	....	..
" 5...	252	162	86	50	17	2.99	0.60	30	3	1	....	....	..
" 6...	241	155	82	48	16	3.00	0.56	27	3	1	....	....	..
" 7...	241	155	82	48	16	2.99	0.53	22	2	1	....	....	..
" 8...	241	155	82	48	16	3.00	0.49	20	1	1	....	....	..
" 9...	241	155	82	48	16	2.99	0.46	20	1	1	....	....	..
" 10...	241	155	82	48	16	3.00	0.44	17	1	1	....	....	..
" 11...	331	212	112	66	22	2.98	0.42	12	1	1	....	....	..
" 12...	318	204	108	64	22	2.98	0.42	11	1	1	....	....	..
" 13...	265	170	90	53	18	3.00	0.40	36	3	1	....	....	..
" 14...	252	162	86	50	17	2.99	0.40	39	5	1	....	....	..
" 15...	241	155	82	48	16	2.99	0.39	25	3	1	....	....	..
" 16...	241	155	82	48	16	2.99	0.40	34	3	1	....	....	..
" 17...	252	162	86	50	17	2.99	0.41	64	11	1	....	....	..
" 18...	241	155	82	48	16	2.99	0.42	57	11	1	....	....	..
" 19...	241	155	82	48	16	2.99	0.42	46	8	1	....	....	..
" 20...	241	155	82	48	16	2.99	0.42	40	5	1	....	....	..
" 21...	241	155	82	48	16	3.00	0.43	28	4	1	....	....	..
" 22...	241	155	82	48	16	2.99	0.43	25	3	1	....	....	..
" 23...	241	155	82	48	16	2.99	0.43	25	3	1	....	....	..
" 24...	241	155	82	48	16	2.99	0.43	29	4	1	....	....	..
" 25...	241	155	82	48	16	2.99	0.43	18	2	1	....	....	..
" 26...	241	155	82	48	16	2.80	0.42	15	1	1	....	....	..
" 27...	241	155	82	48	16	2.99	0.44	12	1	1	....	....	..
" 28...	241	155	82	48	16	2.99	0.44	9	1	1	....	....	..
" 29...	241	155	82	48	16	2.99	0.44	8	1	1	....	....	..
" 30...	241	155	82	48	16	2.99	0.44	10	1	1	....	....	..
July 1...	241	155	82	48	16	3.00	0.45	8	1	1	80	10	4
" 2...	241	155	82	48	16	3.00	0.46	8	1	0	290	24	5
" 3...	241	155	82	48	16	3.00	0.47	8	1	0	350	45	6
" 4...	241	155	82	48	16	2.99	0.49	9	1	0	....	....	..
" 5...	305	195	103	61	21	3.00	0.51	10	1	0	....	....	..
" 6...	241	155	82	48	16	3.00	0.51	9	1	0	300	36	7
" 7...	241	155	82	48	16	2.99	0.53	8	1	0	110	10	3

TABLE 17.—(*Continued.*)

Date.	PUECH SYSTEM:					FINAL FILTER.		TURBIDITY.			BACTERIA.		
	Rates, millions of gallons per acre daily.					Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1908.													
July 8...	252	162	86	50	17	3.00	0.53	9	1	0	85	22	2
" 9...	241	155	82	48	16	3.00	0.54	8	1	0	85	26	2
" 10...	...	...	...	..	..	....	....	..	..	..	200	3	5
" 11...	305	195	103	61	21	3.00	0.56	12	1	0	145	7	3
" 12...	241	155	82	48	16	2.99	0.58	11	1	0	....	....	..
" 13...	241	155	82	48	16	3.00	0.60	10	1	0	115	34	55
" 14...	241	155	82	48	16	2.99	0.62	16	1	0	300	55	30
" 15...	241	155	82	48	16	2.99	0.64	17	1	0	180	32	23
" 16...	241	155	82	48	16	3.00	0.67	13	1	0	100	115	3
" 17...	241	155	82	48	16	2.99	0.71	10	1	0	65	275	5
" 18...	241	155	82	48	16	2.99	0.73	11	1	0	38	425	10
" 19...	241	155	82	48	16	3.00	0.76	12	1	0	....	....	..
" 20...	241	155	82	48	16	2.99	0.79	10	1	0	95	90	70
" 21...	252	162	86	50	17	2.99	0.83	10	1	1	70	17	4
" 22...	241	155	82	48	16	2.99	0.87	13	1	1	450	8	5
" 23...	305	195	103	61	21	2.99	0.92	54	4	1	650	26	5
" 24...	331	212	111	66	22	2.98	0.99	305	61	1	1 650	....	..
" 25...	265	170	90	53	18	2.98	1.08	330	85	1	2 600	115	15
" 26...	252	162	86	50	17	2.98	1.21	290	77	2	......	....	..
" 27...	305	195	103	61	21	2.98	1.40	335	87	2	35 000	250	..
" 28...	252	162	86	50	17	2.98	1.68	170	52	2	1 200	1 350	15
" 29...	252	162	86	50	17	2.97	2.14	180	52	2	2 000	600	13
" 30...	252	162	86	50	17	2.97	2.65	237	56	2	800	1 300	12
" 31...	241	155	82	48	16	2.95	3.01	250	60	2	1 000	310	7

first seven runs. At the end of the seventh run, on October 17th, 1908, the filter was given a very deep scraping and re-sanded.

The layer of clean sand restored the original capacity, and the filter was operated as before, but with gradually decreasing rates until December, 1908, when the rate was reduced to about 40 000 000 gal. Even this lower rate was too high to be maintained without removing and replacing a large part of the sand. The rates, therefore, gradually decreased to about 23 000 000 gal. on March 13th, 1909, when the filter was again re-sanded. After this re-sanding the rate was reduced to about 20 000 000 gal., and the filter was operated at approximately that rate until it was again re-sanded on November 13th, 1909, when the rate was again reduced to about 14 000 000 gal., which was maintained until the filter was put out of service on February 28th, 1910.

This experimental plant was in service from September, 1908, to the latter part of February, 1910, or for about 1½ years, and the leading results are summarized in Table 20.

TABLE 18.—Record of Experimental Filter Plant No. 2.

Date.	Preliminary filter.		Final filter.		Turbidity.			Bacteria.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
Feb. 8....	21.50	0.04	2.81	0.17	....	....	....	1 100	2 100	......
“ 9....	21.60	0.04	1.09	0.06	....	....	....	200	550	2 100
“ 10....	20.90	0.05	1.59	0.08	....	....	....	......	......	......
“ 11....	19.80	0.05	3.01	0.15	12	6	2	600	1 100	1 100
“ 12....	19.70	0.06	3.01	0.14	12	5	2	650	400	700
“ 13....	19.60	0.06	3.01	0.12	15	5	2	600	900	700
“ 14....	24.70	0.07	2.65	0.13	15	6	2	650	1 100	900
“ 15....	37.20	... .	3.40	0.12	12	5	2	600	800	850
“ 16....	37.30	....	3.40	0.11	14	4	2	850	950	600
“ 17....	Shut down for changes in meters and piping.									
“ 18....	......	....	......	....	....	....	....	1 200	......	600
“ 21....	44.50	....	4.36	0.19	20	6	2	1 800	1 400	800
“ 22....	48.60	....	4.37	0.16	15	4	2		Holiday.	
“ 23....	48.40	....	4.20	0.15	20	7	2	1 600	750	380
“ 24....	48.30	....	4.02	0.13	20	10	3		Sunday.	
“ 25....	Shut down several hours.			0.14	20	10	3	1 400	1 000	450
“ 26....	48.60	0.04	4.12	0.14	20	10	3	700	800	260
“ 27....	53.20	0.04	4.08	0.15	17	8	3	700	700	290
“ 28....	52.80	0.04	4.09	0.15	15	8	3	800	650	500
Mar. 1....	53.00	0.04	4.10	0.16	15	8	3	650	550	200
“ 2....	53.30	0.04	4.11	0.16	15	7	3	1 000	800	300
“ 3....	50.60	0.05	4.11	0.16	31	11	3		Sunday.	
“ 4....	42.40	0.05	4.12	0.17	35	15	6	1 200	1 500	360
“ 5....	42.70	0.05	4.11	0.17	135	52	10	13 000	850	....
“ 6....	48.60	0.07	4.13	0.17	135	54	12	18 000	8 000	....
“ 7....	50.50	0.08	4.12	0.18	102	46	8	24 000	6 500	1 800
“ 8....	51.80	0.09	4.12	0.18	100	40	6	22 000	6 000	1 600
“ 9....	53.00	0.10	4.12	0.18	90	40	5	24 000	6 000	800
“ 10....	54.40	0.12	4.11	0.19	82	39	6		Sunday.	
“ 11....	51.00	0.12	4.12	0.19	68	32	7	18 000	4 300	240
“ 12....	51.20	0.12	4.07	0.19	46	25	5	11 000	4 600	210
“ 13....	50.50	0.12	4.00	0.19	40	20	5	9 000	1 500	200
“ 14....	46.50	0.12	....	0.20	39	20	4	5 500	1 200	90
“ 15....	45.80	0.12	3.98	0.20	35	18	4	6 500	1 100	150
“ 16....	42.50	0.12	3.97	0.19	60	24	4	5 000	800	160
“ 17....	49.30	0.14	3.98	0.19	135	45	5		Sunday.	
“ 18....	52.60	0.16	3.98	0.20	170	59	9	9 000	1 700	100
“ 19....	53.50	0.17	4.01	0.19	125	51	8	7 000	1 000	120
“ 20....	52.90	0.17	3.99	0.18	102	40	6	4 800	700	75
“ 21....	48.20	0.16	4.00	0.19	125	42	5	8 500	1 100	90
“ 22....	51.80	0.18	4.01	0.20	190	82	5	7 500	1 100	55
“ 23....	51.60	0.19	4.01	0.20	180	75	6	7 500	1 300	90
“ 24....	48.20	0.17	4.01	0.20	140	68	7		Sunday.	
“ 25....	48.50	0.18	4.01	0.20	88	40	5	4 400	900	75
“ 26....	45.90	0.18	3.98	0.20	62	32	4	3 600	750	90
“ 27....	50.50	0.20	4.04	0.20	47	25	4	2 200	400	60
“ 28....	49.60	0.20	3.92	0.19	35	16	3	1 300	350	55
“ 29....	42.20	0.17	3.98	0.19	26	12	3	700	180	20
“ 30....	48.00	0.22	4.01	0.19	25	7	3	310	220	39
“ 31....	49.10	0.22	3.99	0.20	21	6	2		Sunday.	
April 1....	49.10	0.24	4.00	0.20	20	6	2	600	110	38
“ 2....	49.70	0.25	4.00	0.20	24	6	2	270	110	29
“ 3....	51.40	0.27	4.00	0.21	24	6	2	460	85	31
“ 4....	48.70	0.27	4.00	0.22	20	6	2	280	60	22
“ 5....	48.10	0.27	4.00	0.22	20	5	2	450	70	40
“ 6....	Shut down awaiting Mr. Maignen to apply bone-charcoal.									
“ 7....	Removed 1.06 in. of sand.								Sunday.	

TABLE 18.—(*Continued.*)

Date.	Preliminary filter.		Final filter.		Turbidity.			Bacteria.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
April 8....	52.20	0.33	4.05	0.27	18	4	3	330	......	......
" 9....	46.90	0.29	4.02	0.29	18	4	2	140	60	32
" 10....	47.60	0.31	4.03	0.28	30	4	1	750	120	28
" 11....	46.00	0.30	4.04	0.28	66	7	2	4 000	......	32
" 12....	45.40	0.31	4.03	0.29	72	20	3	14 000	2 900	85
" 13....	45.10	0.32	3.99	0.32	80	30	3	13 000	2 500	95
" 14....	49.00	0.34	4.00	0.32	77	35	4		Sunday.	
" 15....	47.80	0.35	3.99	0.33	62	31	4	7 000	1 100	60
" 16....	47.40	0.36	3.99	0.34	47	27	4	3 600	650	31
" 17....	45.60	0.36	4.00	0.34	39	21	3	1 600	160	38
" 18....	45.70	0.36	4.00	0.34	30	13	2	1 810	210	42
" 19....	45.60	0.37	4.00	0.34	25	9	2	790	190	34
" 20....	45.30	0.40	4.00	0.36	20	6	2	540	87	23
" 21....	47.20	0.44	3.99	0.38	20	4	2		Sunday.	
" 22....	45.20	0.42	3.99	0.38	18	3	1	235	55	22
" 23....	44.90	0.44	4.05	0.40	15	3	1	170	45	16
" 24....	40.50	0.41	4.02	0.44	19	2	1	150	14	14
" 25....	39.60	0.41	4.03	0.45	34	3	1	700	12	23
" 26....	40.70	0.44	4.05	0.45	46	4	1	1 200	80	16
" 27....	39.30	0.44	4.00	0.44	52	4	1	1 700	160	23
" 28....	34.70	0.43	4.05	0.44	45	5	1		Sunday.	
" 29....	37.20	0.45	4.00	0.42	44	6	1	600	60	10
" 30....	43.00	0.49	4.00	0.41	39	7	1	550	55	15
May 1....	41.30	0.49	4.00	0.41	31	6	1	500	80	17
" 2....	42.40	0.49	4.00	0.41	24	5	1	500	80	19
" 3....	40.70	0.48	4.00	0.40	19	4	1	280	75	48
" 4....	33.80	0.47	4.00	0.39	16	3	1	400	80	9
" 5....	26.20	0.43	4.00	0.39	15	1	1		Sunday.	
" 6....	29.00	0.38	3.99	0.37	13	2	1	390	100	65
" 7....	27.60	0.36	....	0.37	12	2	1	190	60	19
" 8....	24.70	0.31	3.99	0.37	10	2	1	......	......	......
	Washed.									
" 9....	24.40	0.03	3.98	0.39	10	2	1	390	65	10
" 10....	24.80	0.04	4.00	0.42	10	2	1	300	80	18
" 11....	50.00	0.06	4.00	0.44	12	2	1	390	110	12
" 12....	50.00	0.08	4.00	0.48	17	2	1		Sunday.	
" 13....	50.00	0.09	4.00	0.47	35	3	1	600	100	18
" 14....	50.00	0.10	4.00	0.46	39	4	1	500	65	15
" 15....	48.50	0.15	4.00	0.45	17	3	1	500	70	16
" 16....	47.00	0.16	4.00	0.46	24	3	1	290	70	16
" 17....	47.00	0.16	3.99	0.47	18	3	1	260	40	9
" 18....	47.00	0.19	4.00	0.48	15	2	1	190	......	17
" 19....	47.00	0.21	3.99	0.51	12	2	1		Sunday.	
" 20....	46.60	0.24	4.00	0.53	12	2	1	260	40	13
" 21....	46 40	0.24	4.00	0.55	16	2	1	260	65	9
" 22....	46.40	0.27	4.00	0.58	20	2	1	280	35	12
" 23....	46.40	0.29	4.00	0.61	15	2	1	130	35	10
" 24....	46.40	0.30	4.00	0.63	15	2	1	170	26	6
" 25....	46.40	0.32	4.00	0.66	15	2	1	340	80	13
" 26....	46.40	0.34	3.99	0.70	18	2	1		Sunday.	
" 27....	46.40	0.36	3.99	0.74	13	2	1	210	80	7
" 28....	46.40	0.38	3.15	0.76	16	2	1	260	70	10
" 29....	46.00	0.44	3.88	0.78	16	2	1	500	55	12
" 30....	45.60	0.46	3.99	0.86	14	2	1		Holiday.	
" 31....	45.60	0.46	4.00	0.92	17	2	1	380	65	11

TABLE 18.—(*Continued.*)

Date.	PRELIMINARY FILTER.		FINAL FILTER.		TURBIDITY.			BACTERIA.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
June 1.....	45.60	0.46	4.00	0.98	15	2	1	900	48	10
" 2.....	45.60	0.48	4.00	1.09	17	2	1		Sunday.	
" 3.....	45.60	0.51	4.00	1.20	24	2	1	550	75	16
" 4.....	45.60	0.54	4.00	1.32	37	3	1	6 500	......	22
" 5.....	45.60	0.55	4.00	1.48	65	5	1	3 200	140	19
" 6.....	45.60	0.56	4.01	1.66	77	16	1	1 500	210	14
" 7.....	45.00	0.57	4.00	1.80	64	27	1	2 100	230	20
" 8.....	45.00	0.57	4.00	1.90	46	22	1	600	240	33
" 9.....	45.00	0.55	4.01	2.00	44	18	1		Sunday.	
" 10.....	45.00	0.56	4.00	2.09	36	12	1	240	110	43
" 11.....	45.00	0.58	4.60	2.17	30	8	1	280	130	60
" 12.....	45.00	0.60	4.01	2.27	34	8	1	330	150	60
" 13.....	45.00	0.62	4.00	2.36	35	10	1	480	....	120
" 14.....	45.00	0.63	3.99	2.49	31	9	1	440	....	65
" 15.....	45.00	0.64	3.99	2.56	32	8	1	420	....	49
" 16.....	44.70	0.65	4.00	2.63	26	7	1		Sunday.	
" 17.....	44.40	0.64	4.00	2.67	26	6	1	340	270	55
" 18.....	45.00	0.63	3.98	2.69	31	7	1	440	140	65
" 19.....	45.00	0.63	4.00	2.73	37	10	1	500	110	24
" 20.....	45.00	0.62	4.01	2.72	30	9	1	330	70	34
" 21.....	45.00	0.61	4.01	2.68	25	7	1	170	130	60
" 22.....	Shut down to scrape and apply asbestos and coke; removed 0.79 in. of sand.									
" 23.....	Applied 8 lb. of asbestos and 10 lb. of bone-charcoal.									
" 25.....	50.00	0.54	4.00	0.27	130	45	1	400	....	....
" 26.....	50.00	0.57	4.01	0.46	82	37	1	750	550	35
" 27.....	50.00	0.63	4.01	0.55	65	26	1	....	1 200	140
" 28.....	50.00	0.65	3.99	0.63	47	21	1	....	1 200	26
" 29.....	50.00	0.70	4.00	0.73	37	9	1	220	800	22
" 30.....	50.00	0.77	3.99	0.82	30	8	1		Sunday.	
July 1.....	50.00	0.87	4.00	0.80	30	8	1	400	90	37
" 2.....	50.00	0.95	4.01	0.73	32	9	1	180	230	25
" 3.....	50.00	1.01	4.00	0.66	36	10	1	350	80	58
" 4.....	50.00	1.03	4.00	0.58	44	12	1		Holiday.	
" 5.....	50.00	1.07	3.99	0.54	24	14	1	550	130	47
" 6.....	50.00	1.10	4.00	0.52	39	12	1	250	110	33
" 7.....	50.00	1.14	4.00	0.50	34	10	1		Sunday.	
" 8.....	50.00	1.16	4.00	0.48	25	7	1	220	190	14
" 9.....	50.00	1.18	4.00	0.46	22	5	1	50	30	3
" 10.....	50.00	1.20	3.99	0.45	47	11	1	Lost.	Lost.	Lost.
" 11.....	50.00	1.20	3.99	0.45	90	30	1	150	140	12
" 12.....	50.00	1.20	4.01	0.44	97	35	1	300	110	20
" 13.....	50.00	1.15	4.00	0.47	90	39	1	220	120	14
" 14.....	50.00	1.15	4.00	0.48	90	40	1		Sunday.	
" 15.....	50.00	1.14	3.99	0.48	95	40	1	375	320	19
" 16.....	50.00	1.19	4.00	0.48	120	45	1	Lost.	150	12
" 17.....	50.00	1.21	4.00	0.48	85	42	1	270	60	5
" 18.....	50.00	1.19	3.99	0.50	56	32	1	1 675	23	39
" 19.....	50.00	1.16	3.99	0.52	41	20	1	450	200	13
" 20.....	50.00	1.16	3.99	0.56	62	29	1	300	220	8
" 21.....	50.00	1.19	3.99	0.63	62	31	1		Sunday.	
" 22.....	50.00	1.20	3.99	0.77	80	36	1	1 400	700	9
" 23.....	50.00	1.21	3.99	0.93	105	40	1	3 700	370	25
" 24.....	50.00	1.18	3.99	1.07	95	40	1	770	260	31
" 25.....	50.00	1.17	3.99	1.22	77	32	1	250	230	3
" 26.....	50.00	1.07	4.00	1.37	67	29	1	140	90	12

TABLE 18.—(*Continued.*)

Date.	PRELIMINARY FILTER.		FINAL FILTER.		TURBIDITY.			BACTERIA.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
July 27....	50.00	1.11	4.00	1.51	54	25	1	300	180	6
" 28....	50.00	1.22	3.98	1.65	46	19	1	Sunday.		
" 29....	50.00	1.21	4.00	1.82	36	16	1	470	230	18
" 30....	50.00	1.20	3.99	1.98	29	11	1	Plates lost.		
" 31....	50.00	1.20	3.99	2.11	21	9	1	" "		
Aug. 1....	51.00	1.21	3.99	2.27	16	6	1	Plates lost.		
" 2....	51.00	1.21	3.99	2.43	15	4	1	130	130	4
" 3....	51.00	1.21	4.00	2.66	16	3	1	120	80	4
" 4....	50.00	1.21	3.99	2.95	21	3	1	Sunday.		
" 5....	50.00	1.21	3.98	3.22	29	3	1	230	210	4
" 6....	50.00	1.22	3.98	3.50	34	4	1	85	320	19
" 7....	50.00	1.21	3.99	3.74	21	4	1	200	Lost.	19
" 8....	48.20	1.20	....	4.09	19	4	1	100	150	17
" 9....	50.00	1.18	....	4.45	16	3	1	75	220	9
" 10....	47.30	1.16	....	4.67	24	3	1	60	250	10
" 11....	Shut down to drain and scrape sand filter; 0.9 in. depth over all.									
" 16....	Out of service all the rest of month washing sponge and asbestos.									
Sept. 3....	50.00	0.02	4.00	0.16	12	5	1	300	......	......
" 4....	50.00	0.02	3.99	0.14	16	6	1	600	260	370
" 5....	50.00	0.02	4.01	0.13	34	6	1	360	71	165
" 6....	46.40	0.02	4.00	0.12	160	52	1	15 000	1 900	120
" 7....	50.00	0.03	4.00	0.11	64	26	1	2 000	170	62
" 8....	46.40	0.04	3.99	0.11	56	25	1	Sunday.		
" 9....	50.00	0.05	4.90	0.11	59	25	1	220	13	19
" 10....	50.00	0.05	4.00	0.11	57	21	1	18 000	100	24
" 11....	50.00	0.06	4.00	0.11	65	25	1	2 700	150	25
" 12....	50.00	0.07	4.00	0.12	72	26	1	1 000	190	36
" 13....	50.00	0.08	4.00	0.12	87	30	1	2 300	......	35
" 14....	50.00	0.09	4.01	0.12	72	27	1	2 400	130	230
" 15....	48.20	0.11	4.00	0.12	65	25	1	Sunday.		
" 16....	51.00	0.13	4.00	0.12	65	25	1	Lost.	Lost.	27
" 17....	50.00	0.14	4.00	0.12	52	21	1	420	60	29
" 18....	49.10	0.14	4.00	0.13	60	18	1	900	80	41
" 19....	50.00	0.15	4.00	0.13	85	22	1	2 000	......	19
" 20....	49.10	0.17	4.00	0.13	100	29	1	4 200	300	28
" 21....	49.10	0.18	4.00	0.13	120	34	1	1 100	160	30
" 22....	48.20	0.20	4.00	0.13	137	41	1	Sunday.		
" 23....	49.10	0.19	4.00	0.13	112	37	1	2 400	90	34
" 24....	46.40	0.19	3.99	0.14	100	35	1	4 000	210	12
" 25....	46.40	0.20	4.00	0.14	432	80	1	56 000	510	27
" 26....	45.60	0.24	4.00	0.15	385	80	4	1 300	450	55
" 27....	44.80	0.27	4.00	0.16	245	70	3	4 000	240	41
" 28....	46.40	0.30	3.99	0.16	127	46	2	15 000	430	37
" 29....	46.40	0.31	3.99	0.16	105	41	2	Sunday.		
" 30....	46.40	0.31	4.00	0.17	115	42	1	Lost.	1 600	110
Oct. 1....	48.20	0.33	4.00	0.18	82	36	1	600	600	120
" 2....	50.00	0.33	4.01	0.19	65	27	1	4 400	170	47
" 3....	48.20	0.33	4.00	0.19	59	24	1	900	210	44
" 4....	48.20	0.34	4.00	0.19	55	20	1	850	200	37
" 5....	50.00	0.38	4.00	0.19	9	21	1	2 000	150	34
" 6....	48.20	0.41	4.00	0.19	59	24	1	Sunday.		
" 7....	48.20	0.42	4.00	0.19	552	17	1	1 250	200	28
" 8....	50.00	0.42	4.00	0.19	54	16	1	11 000	210	28
" 9....	44.80	0.40	4.00	0.19	51	16	1	2 000	310	29

TABLE 18.—(*Continued.*)

Date.	Preliminary filter.		Final filter.		Turbidity.			Bacteria.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907. Oct. 10....	48.20	0.42	4.00	0.19	50	15	1	800	220	16
" 11....	48.20	0.43	4.00	0.20	47	13	1	2 000	310	46
	Washed.									
" 12....	50.00	0.14	4.00	0.20	36	11	1	1 200	370	25
" 13....	47.30	0.15	4.00	0.21	40	15	1		Sunday.	
" 14....	50.00	0.18	4.00	0.22	47	19	1	1 200	390	22
" 15....	53.00	0.20	4.00	0.23	41	16	1	900	140	16
" 16....	50.00	0.20	4.00	0.24	35	12	1	Lost.	310	18
" 17....	50.00	0.21	4.00	0.25	30	8	1	550	180	7
" 18...	50.00	0.21	4.00	0.25	25	6	1	260	100	33
" 19....	50.00	0.21	4.00	0.25	25	6	1	750	220	15
" 20....	50.00	0.22	4.00	0.25	20	5	1		Sunday.	
" 21....	50.00	0.23	4.00	0.25	19	5	1	480	120	11
" 22....	50.00	0.24	4.00	0.26	18	4	1	230	70	7
" 23....	50.00	0.25	4.00	0.26	15	3	1	250	120	12
" 24....	50.00	0.26	4.00	0.26	15	3	1	300	80	12
" 25....	50.00	0.27	4.00	0.27	15	2	1	450	60	15
" 26....	50.00	0.28	4.00	0.27	15	2	1	450	Lost.	14
" 27....	50.00	0.29	4.00	0.27	13	2	0		Sunday.	
" 28....	50.00	0.30	4.00	0.27	13	2	0	190	110	9
" 29....	50.00	0.31	4.00	0.27	25	2	0	380	.....	.....
" 30....	50.00	0.32	4.00	0.27	21	3	0	......	.....	.....
" 31....	Out of commission, 4-in. supply pipe stopped up.									
Nov. 4....	50.00	0.16	4.00	0.28	125	11	1	......	......	.....
" 5....	50.00	0.17	4.00	0.28	185	61	1	6 000	3 000	220
" 6....	50.00	0.18	4.00	0.29	170	66	1	5 000	1 100	150
" 7....	50.00	0.20	4.00	0.30	100	45	1	14 000	1 600	120
" 8....	50.00	0.21	4.00	0.32	95	42	1	1 900	2 000	29
" 9....	50.00	0.22	4.00	0.34	80	36	1	4 000	2 000	110
" 10....	50.00	0.23	4.00	0.36	67	29	1		Sunday.	
" 11....	50.00	0.24	3.46	0.38	52	20	1	1 900	460	160
" 12....	50.00	0.26	3.99	0.40	40	13	1	7 500	1 100	110
" 13....	50.00	0.27	4.00	0.44	36	10	1	1 600	550	50
" 14....	50.00	0.28	4.00	0.49	42	13	1	2 700	950	48
" 15....	50.00	0.29	4.00	0.55	35	11	1	1 800	900	49
" 16....	50.00	0.30	4.00	0.65	26	7	1	1 100	360	35
" 17....	50.00	0.31	3.98	0.80	20	5	1		Sunday.	
" 18....	50.00	0.32	3.99	0.98	17	4	1	1 600	200	35
" 19....	50.00	0.34	3.99	1.26	16	3	1	1 300	400	55
" 20....	50.00	0.35	3.98	1.64	45	4	1	6 500	3 500	200
" 21....	50.00	0.36	3.99	2.03	52	12	1	9 900	4 500	130
" 22....	50.00	0.37	3.98	2.33	65	24	1	10 000	5 500	220
" 23....	50.00	0.38	3.99	2.60	49	19	1	18 000	3 500	100
" 24....	50.00	0.40	3.98	2.85	134	32	1		Sunday.	
" 25....	48.20	0.45	3.98	3.10	225	87	2	50 000	19 000	340
" 26....	50.00	0.49	3.98	3.62	237	90	2	40 000	11 000	220
" 27....	50.00	0.51	3.99	4.15	185	77	2	16 000	7 500	310
" 28....	50.00	0.54	3.84	4.44	130	57	2		Holiday.	
" 29....	50.00	0.55	3.67	4.55	80	36	1	10 000	2 200	80
" 30....	50.00	0.56	3.44	4.65	54	25	1	3 800	2 200	55
Dec. 2....	Shut down to scrape sand filter.									
" 6....	50.00	0.64	4.00	0.46	16	3	1	......	......	.....
" 7....	50.00	0.64	4.00	0.39	14	3	1	2 400	1 200	490
" 8....	50.00	0.64	4.01	0.35	12	2	1		Sunday.	
" 9....	50.00	0.65	4.01	0.33	11	2	1	1 200	420	60

TABLE 18.—(*Continued.*)

Date.	PRELIMINARY FILTER.		FINAL FILTER.		TURBIDITY.			BACTERIA.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate. millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1907.										
Dec. 10....	50.00	0.65	4.00	0.33	12	2	1	800	950	60
" 11....	47.30	0.64	4.00	0.35	255	84	3	6 500	1 600	140
" 12....	46.40	0.70	3.98	0.39	212	100	6	48 000	15 000	1 800
" 13....	50.00	0.79	3.98	0.49	495	217	9	42 000	20 000	1 600
" 14....	52.00	0.84	3.97	0.65	357	167	9	49 000	9 500	1 200
" 15....	49.10	0.84	3.98	0.77	157	76	6		Sunday.	
" 16....	49.10	0.86	3.97	0.84	90	42	4	19 000	800	700
" 17....	49.10	0.88	3.98	0.91	70	31	2	21 000	18 000	1 600
" 18....	48.20	0.89	3.98	0.94	49	21	2	6 500	7 000	600
" 19....	50.00	0.91	3.98	0.97	39	13	1	Lost.	Lost.	Lost.
" 20....	49.10	0.92	3.98	1.03	42	16	1	"	"	"
" 21....	50.00	0.94	3.98	1.08	26	7	1	"	"	"
" 22....	50.00	0.97	3.98	1.13	20	5	1		Sunday.	
" 23....	50.00	0.95	3.98	1.19	34	9	1	1 400	500	160
" 24....	47.30	0.93	3.98	1.28	195	75	2	9 000	1 700	130
" 25....	44.10	0.91	3.97	1.47	445	210	9		Holiday.	
" 26....	46.40	1.01	3.97	1.63	370	172	7	51 000	8 000	250
" 27....	50.00	1.11	3.98	1.81	245	110	5	55 000	5 600	210
" 28....	48.20	1.12	3.99	1.87	102	46	3	10 000	4 500	140
" 29....	50.00	1.14	3.99	1.85	75	32	2		Sunday.	
" 30....	49.10	1.15	3.98	1.86	56	24	2	4 400	1 900	190
" 31....	50.00	1.17	4.00	1.87	39	15	1	14 000	1 300	60
1908.										
Jan. 1....	50.00	1.18	3.98	1.90	31	8	1	......	.....	.....
" 2....	50.00	1.18	3.99	1.94	39	11	1	4 400	750	45
" 3....	50.00	1.19	3.98	1.98	36	11	1	3 100	1 600	70
	Washed.									
" 4....	50.00	0.17	3.97	2.09	32	9	1	2 400	1 200	43
" 5....	50.00	0.18	3.98	2.22	26	6	1		Sunday.	
" 6....	50.00	0.19	3.98	2.28	20	5	1	600	600	49
" 7....	50.00	0.20	3.98	2.37	20	5	1	1 100	330	49
" 8....	50.00	0.21	3.99	2.43	22	5	1	1 900	900	43
" 9....	50.00	0.23	3.98	2.52	45	13	1	13 000	3 400	50
" 10....	50.00	0.24	3.99	2.66	70	30	1	10 000	8 000	50
" 11....	50.00	0.27	3.98	2.74	56	22	1	16 000	220	200
" 12....	50.00	0.28	3.98	2.83	40	12	1		Sunday.	
" 13....	49.10	0.30	3.98	2.93	110	51	2	8 500	1 200	43
" 14....	48.20	0.33	3.99	3.04	210	113	4	16 000	6 000	280
" 15....	46.40	0.35	3.98	3.21	325	222	15	24 000	9 500	700
" 16....	50.00	0.40	3.98	3.49	360	247	42	28 000	14 000	900
" 17....	50.00	0.43	3.98	3.86	242	147	26	65 000	20 000	1 200
" 18....	50.00	0.46	3.91	3.99	137	73	7	7 000	6 500	400
" 19....	.....	....	....	....	...	...	..		Sunday.	
" 20....	Scraped.									
" 21....	50.00	0.48	3.00	0.76	55	25	4	......	......	.....
" 22....	50.00	0.48	3.01	0.60	49	21	4	3 600	1 900	150
" 23...	50.00	0.49	3.00	0.57	40	15	3	1 800	700	170
" 24....	50.00	0.49	2.99	0.60	40	13	3	2 300	950	90
" 25....	50.00	0.50	2.99	0.65	39	12	3	1 100	800	95
" 26....	50.00	0.50	2.98	0.69	32	9	2		Sunday.	
" 27....	50.00	0.51	2.99	0.76	32	9	2	300	700	70
" 28....	50.00	0.52	2.99	0.82	45	15	2	1 200	900	70
" 29....	50.00	0.55	2.99	0.90	60	26	2	1 000	1 400	95
" 30....	50.00	0.57	2.98	0.98	57	27	2	1 400	210	33
" 31....	50.00	0.58	2.98	1.08	42	18	2	1 100	750	45

TABLE 18.—(*Continued.*)

Date.	Preliminary filter.		Final filter.		Turbidity.			Bacteria.		
	Rate, millions of gallons per acre daily.	Loss of head.	Rate, millions of gallons per acre daily.	Loss of head.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.	Applied water.	Effluent, preliminary filter.	Effluent, final filter.
1908.										
Feb. 1....	50.00	0.59	2.99	1.16	39	14	2	750	1 000	70
" 2....	49.10	0.60	2.99	1.22	27	9	2		Sunday.	
" 3....	49.10	0.61	2.98	1.30	29	8	2	1 300	750	20
" 4....	50.00	0.64	2.99	1.40	25	6	2	600	900	60
" 5....	50.00	0.66	2.99	1.50	24	6	2	750	1 200	75
" 6....	50.00	0.67	2.99	1.55	20	5	2	2 000	800	60
" 7....	50.00	0.68	3.00	1.56	17	4	1	.....	600	34
" 8....	50.00	0.69	3.00	1.53	15	4	1	900	220	35
" 9....	50.00	0.71	3.00	1.54	14	4	1		Sunday.	
" 10....	50.00	0.72	2.99	1.60	11	4	1	850	500	28
" 11....	50.00	0.74	2.99	1.62	10	4	1	1 000	500	23
" 12....	50.00	0.75	2.98	1.68	8	4	1	750	290	18
" 13....	50.00	0.76	2.99	1.74	9	4	1	700	260	10
" 14....	48.20	0.76	2.99	1.77	9	4	1	1 200	250	27
" 15....	51.80	0.79	2.99	1.89	61	18	1	5 500	4 800	13
" 16....	48.20	0.79	2.99	2.08	80	40	2		Sunday.	
" 17....	48.20	0.81	2.99	2.24	80	40	3	33 000	1 300	60
" 18....	47.30	0.82	2.99	2.31	130	65	3	.....	950	120
" 19....	51.80	0.92	2.99	2.45	320	200	7	28 000	22 000	360
" 20....	52.70	0.99	2.99	2.61	177	97	9	22 000	16 300	350
" 21....	51.80	1.03	2.99	2.68	105	52	6	10 600	3 800	270
" 22....	50.90	1.07	2.99	2.72	85	42	5		Holiday.	
" 23....	50.00	1.09	2.99	2.76	60	30	4		Sunday.	
" 24....	51.80	1.12	2.99	2.80	46	19	3	3 600	1 700	120
" 25....	50.00	1.14	2.99	2.84	31	9	2	2 300	1 300	60
" 26....	50.00	1.17	3.00	2.87	30	8	2	3 800	1 300	43
" 27....	48.20	1.18	2.99	2.90	30	7	1	1 300	900	42
" 28....	47.30	1.19	2.99	2.94	37	7	1	1 400	800	31
" 29....	51.80	1.23	2.99	3.01	123	49	2	13 500	750	35
Mar. 1....	48.20	1.20	2.98	2.99	97	44	5		Sunday.	
" 2....	50.00	1.28	2.99	3.12	82	35	4	8 000	2 500	70
" 3....	50.90	1.32	2.98	3.22	87	38	4	11 000	6 000	55
" 4....	50.00	1.33	2.99	3.28	67	29	3	6 000	1 400	38
" 5....	50.00	1.35	2.99	3.32	59	23	3	4 400	2 500	37
" 6....	Discontinued; sand filter being used for sedimentation experiments.									

TABLE 19.—RECORD OF EXPERIMENTAL FILTER PLANT No. 3.

Date.	SAND FILTER.		TURBIDITY.			BACTERIA.			COAGULANT.
	Rate.	Loss of head.	Applied water.	Effluent, coagulant.	Effluent, sand.	Applied water.	Effluent, coagulant.	Effluent, sand.	Grains, per gallon.
1907.									
Feb. 12......	2.99	0.18	14	..	2	......	......	......	......
" 13......	3.00	0.17	15	..	2	600	......	......	......
" 14......	3.19	0.18	15	..	2	650	......	......	......
" 15......	3.86	0.22	12	..	2	600	......	2 500	......
" 16......	3.84	0.29	14	..	2	850	......	1 600	......
" 17......	....	....	....	..	..	......	......	......	......
" 18......	....	....	....	..	..	1 200	......	300	......
" 21......	3.91	0.32	20	..	2	1 800	......	550	......
" 22......	3.95	0.39	15	..	2		Holiday.		
" 23......	3.94	0.43	20	..	3	1 600	......	1 100	......
" 24......	3.89	0.47	20	..	3		Sunday.		
" 25......	4.19	0.52	20	..	3	1 400	......	600	......
" 26......	4.13	0.57	20	..	3	700	......	650	......
" 27......	3.32	0.62	17	..	3	700	......	2 300	......
" 28......	4.41	0.67	15	..	3	800	......	550	......
Mar. 1......	3.91	0.72	15	..	3	650	......	300	......
" 2......	3.93	0.79	15	..	3	1 000	......	270	......
" 3......	3.90	0.82	31	..	3		Sunday.		
" 4......	3.92	0.80	35	..	3	1 200	......	140	1.45
" 5......	3.96	0.98	135	..	4	13 000	......	190	1.94
" 6......	4.05	1.25	135	29	2	18 000	2 100	160	2.03
" 7......	3.95	1.52	102	15	1	24 000	3 500	160	1.50
" 8......	3.90	1.67	100	15	1	22 000	1 800	130	1.38
" 9......	3.93	1.80	90	15	1	24 000	3 500	130	1.37
" 10......	3.95	1.91	82	16	1		Sunday.		1.26
" 11......	3.96	2.08	68	18	1	18 000	6 000	120	1.24
" 12......	4.02	2.19	46	18	1	11 000	9 000	140	1.08
" 13......	4.02	2.31	40	15	1	9 000	5 000	120	0.94
" 14......	3.96	2.44	39	16	1	5 500	3 600	90	0
" 15......	4.07	2.42	35	20	1	6 500	3 800	85	0
" 16......	3.85	2.20	60	29	1	5 000	3 500	100	1.26
" 17......	3.95	2.21	135	25	1		Sunday.		1.52
" 18......	3.88	2.86	170	25	1	9 000	1 900	85	1.75
" 19......	3.82	3.31	125	21	1	7 000	700	65	1.57
" 20......	3.78	3.47	102	20	1	4 800	1 500	60	1.31
" 21......	3.71	3.70	125	20	1	8 500	1 500	70	1.38
" 22......	3.64	3.81	190	25	1	7 500	1 100	35	1.57
" 23......	3.58	3.95	180	26	1	7 500	470	55	1.68
" 24......	3.46	4.18	140	19	1		Sunday.		1.52
" 25......	Scraped, 1.03 in. of sand removed.								
" 27......	4.06	0.22	47	8	1	2 200	480	60	1.08
" 28......	4.02	0.37	35	..	0	1 300	250	80	1.00
" 29......	4.02	0.46	26	..	..	700	240	65	0
" 30......	Shut down to fill coagulant basin.								
	....	....	25	..	..	310	......	......	0
" 31......	4.00	0.45	21	15	1		Sunday.		0
Apr. 1......	3.39	0.42	20	15	1	600	1 000	43	0
" 2......	3.06	0.46	24	17	1	270	Lost.	35	0
" 3......	3.01	0.49	24	17	1	460	"	41	0
" 4......	2.95	0.50	20	15	1	280	550	27	0
" 5......	2.95	0.51	20	13	1	450	1 000	60	0
" 6......	2.96	0.49	20	12	1	320	50	35	0
" 7......	2.99	0.48	20	12	1		Sunday.		0
" 8......	3.01	0.49	18	12	1	330	650	22	0
" 9......	3.01	0.55	18	12	1	140	750	21	0
" 10......	3.02	0.57	30	15	0	750	5 000	29	0
" 11......	3.04	0.61	66	16	0	4 000	550	25	1.11
" 12......	3.09	0.72	72	13	0	14 000	2 200	17	1.15
" 13......	3.07	0.88	80	19	0	13 000	3 900	25	1.14

TABLE 19.—(*Continued.*)

Date.	Sand filter.		Turbidity.			Bacteria.			Coagulant.
	Rate.	Loss of head.	Applied water.	Effluent, coagulant.	Effluent, sand.	Applied water.	Effluent, coagulant.	Effluent, sand.	Grains, per gallon.
1907.									
Apr. 14....	2.98	1.04	77	18	1		Sunday.		1.17
" 15.....	2.97	1.20	62	18	1	7 000	2 200	19	1.09
" 16.....	3.01	1.32	47	17	1	3 600	900	22	1.08
" 17.....	3.05	1.44	39	19	0	1 600	1 100	12	0
" 18.....	3.04	1.41	30	20	1	1 810	1 870	14	0
" 19.....	3.04	1.35	25	18	1	790	910	14	0
" 20.....	3.07	1.30	20	15	1	540	480	15	0
" 21.....	3.07	1.26	20	15	1		Sunday.		..
" 22.....	3.04	1.21	18	12	0	235	420	21	0
" 23.....	3.06	1.22	15	10	0	170	420	8	0
" 24.....	2.99	1.26	19	10	0	150	250	17	0
" 25.....	3.04	1.27	34	12	0	700	260	19	0
" 26.....	3.07	1.28	46	12	0	1 200	320	80	0
" 27.....	2.94	1.49	52	..	0	1 700	1 500	70	0
" 28.....	2.96	1.88	45	..	1		Sunday.		0
" 29.....	2.99	2.40	44	33	1	600	1 400	19	0
" 30.....	3.00	2.83	39	29	1	550	1 200	14	0
May 1.....	3.01	2.71	31	21	1	500	1 300	20	0
" 2.....	3.01	2.51	24	15	1	500	850	16	0
" 3.....	3.00	2.36	19	12	1	280	650	34	0
" 4.....	3.01	2.29	16	10	0	400	550	24	0
" 5.....	8.01	2.25	15	9	0		Sunday.		0
" 6.....	3.06	2.32	13	8	0	390	460	80	0
" 7.....	2.96	2.46	12	7	0	190	......	18	0
" 8.....	3.00	2.51	10	5	0	......	......	......	0
" 9.....	3.00	2.77	10	5	0	390	1 100	14	0
" 10.....	3.01	2.87	10	5	0	300	500	21	0
" 11.....	2.99	3.16	12	6	0	390	650	16	0
" 12.....	3.00	3.34	17	7	0		Sunday.		0
" 13.....	3.00	3.44	35	9	0	600	470	27	0
" 14.....	3.01	3.46	39	12	0	500	550	25	0
" 15.....	3.01	3.56	17	..	0	500	900	23	0
" 16.....	2.93	4.07	24	..	0	290	2 500	25	0
" 17.....	3.01	4.34	18	..	0	260	2 000	16	0
" 18.....	2.93	4.25	15	8	0	190	600	19	0
" 19.....	2.97	4.36	12	8	0		Sunday.		0
" 20.....	3.01	4.64	12	8	0	260	450	15	0
" 21.....	2.99	4.55	16	8	0	260	330	14	0
" 22.....	3.01	4.57	20	8	0	280	390	22	0
" 23.....	3.00	4.51	15	8	0	130	240	19	0
" 24.....	2.98	4.44	15	8	0	170	240	30	0
" 25.....	3.00	4.38	15	8	0	340	400	41	0
" 26.....	3.00	4.38	18	8	0		Sunday.		0
" 27.....	Shut down to scrape sand filter; 1.09 in. of sand removed. Cleaning coagu-								
" 28.....	lant basin and treating coagulant basin with 1:2 000 000 solution of copper								
" 29.....	sulphate.		16	..	..	......	......	......	......
" 30.....	3.00	0.11	14	8	1		Holiday.		0
" 31....	3.01	0.10	17	8	1	380	18 000	150	0
June 1.....	3.01	0.09	15	8	1	900	7 000	150	0
" 2.....	3.01	0.10	17	8	1		Sunday.		0
" 3.....	3.01	0.10	24	10	1	550	8 000	130	0
" 4.....	3.04	0.11	37	13	1	6 500	7 500	140	0
" 5.....	3.00	0.11	65	29	1	3 200	3 000	110	0
" 6.....	3.00	0.11	77	46	1	1 500	800	60	1.17
" 7.....	2.99	0.12	64	21	1	2 100	1 500	90	1.18
" 8.....	2.98	0.17	46	22	1	600	1 000	60	0
" 9.....	3.00	0.18	44	30	1		Sunday.		0
" 10.....	3.01	0.18	36	26	1	2 40	400	32	0

TABLE 19.—(*Continued.*)

Date.	SAND FILTER.		TURBIDITY.			BACTERIA.			COAGULANT.
	Rate.	Loss of head.	Applied water.	Effluent, coagulant.	Effluent, sand.	Applied water.	Effluent, coagulant.	Effluent, sand.	Grains, per gallon.
1907.									
June 11.....	3.00	0.17	30	20	1	280	300	31	0
" 12.....	3.00	0.17	34	22	1	330	......	28	0
" 13.....	2.99	0.17	35	25	1	480	480	39	0
" 14.....	2.98	0.17	31	22	1	440	550	32	0
" 15.....	2.99	0.19	32	22	1	420	450	27	0
" 16.....	3.02	0.21	26	18	1		Sunday.		0
" 17.....	2.99	0.23	26	16	1	240	750	14	0
" 18. ...	3.02	0.25	31	20	1	440	750	21	0
" 19.....	3.02	0.29	37	27	1	500	460	35	0
" 20.....	3.00	0.32	30	21	1	330	440	38	0
" 21.....	3.01	0.36	25	16	1	170	370	23	0
" 22.....	3.00	0.40	20	12	1	100	300	17	0
" 23.....	2.97	0.43	26	11	1		Sunday.		0
" 24.....	2.97	0.44	140	36	1	1 700	350	22	1.59
" 25.....	3.02	0.45	130	27	1	400	250	16	1.55
" 26.....	Interrupted, defective meter.					750	330	......	0
" 27.....	3.00	0.43	65	15	0	......	1 400	......	0
" 28.....	3.00	0.44	47	19	0	......	1 400	120	0
" 29.....	2.99	0.44	37	20	0	220	300	......	0
" 30.....	2.97	0.42	30	19	0		Sunday.		0
July 1.....	2.99	0.37	30	18	0	400	600	85	0
" 2.....	3.01	0.33	32	19	0	180	1 000	50	0
" 3.....	3.00	0.31	36	21	0	350	310	21	0
" 4.....	3.00	0.30	44	30	0		Holiday.		
" 5.....	3.00	0.29	44	35	0	550	400	41	0
" 6.....	3.00	0.28	39	30	0	250	280	22	0
" 7.....	3.00	0.28	34	24	0		Sunday.		0
" 8.....	3.00	0.28	25	16	0	220	260	27	0
" 9.....	3.00	0.27	22	13	0	50	40	19	0
" 10.....	2.98	0.27	47	27	1	Lost.	Lost.	Lost.	0
" 11.....	3.00	0.27	90	41	1	150	50	8	1.27
" 12.....	3.00	0.29	97	21	1	300	200	13	1.27
" 13.....	3.00	0.34	90	20	0	220	160	17	1.27
" 14.....	3.00	0.40	90	19	0		Sunday.		1.27
" 15.....	3.00	0.54	95	18	0	375	150	......	1.27
" 16.....	3.00	0.59	120	20	0	Lost.	50	Lost.	1.36
" 17.....	3.00	0.58	85	16	0	270	60	3	1.26
" 18.....	2.99	0.61	56	13	0	1 675	70	......	1.17
" 19.....	3.01	0.61	41	18	0	450	700	11	0
" 20.....	2.99	0.51	62	27	0	300	720	8	0
" 21.....	3.00	0.47	62	32	0		Sunday.		0
" 22.....	3.00	0.47	80	34	0	1 400	560	14	1.17
" 23.....	3.01	0.49	105	21	0	3 700	490	40	1.25
" 24.....	3.01	0.60	95	19	0	770	110	80	1.27
" 25.....	3.00	0.68	77	16	0	250	80	5	1.22
" 26.....	2.99	0.68	67	17	0	140	40	4	0
" 27.....	3.00	0.69	54	20	0	300	130	21	0
" 28.....	3.00	0.72	46	27	0		Sunday.		0
" 29.....	3.00	0.74	36	26	0	470	290	100	0
" 30.....	2.99	0.76	29	19	0	Lost.	Lost.	Lost.	0
" 31.....	2.99	0.77	21	12	0	"	"	"	0
Aug. 1.....	3.00	0.75	16	9	0	Lost.	Lost.	Lost.	0
" 2.....	3.00	0.74	15	8	0	130	140	4	0
" 3.....	3.00	0.74	16	7	0	120	180	6	0
" 4.....	3.00	0.75	21	6	0		Sunday.		
" 5.....	3.00	0.76	29	8	0	230	100	44	0
" 6.....	3.00	0.79	34	12	0	85	470	......	0
" 7.....	2.99	1.01	21	12	0	200	450	......	0
" 8.....	3.00	1.31	19	11	0	100	180	45	0

TABLE 19.—(*Continued.*)

Date.	Sand filter.		Turbidity.			Bacteria.			Coagulant.
	Rate.	Loss of head.	Applied water.	Effluent, coagulant.	Effluent, sand.	Applied water.	Effluent, coagulant.	Effluent, sand.	Grains, per gallon.
1907.									
Aug. 9......	2.98	1.44	16	9	0	75	80	16	0
“ 10......	3.00	1.44	24	9	0	60	90	11	0
“ 11......	3.00	1.49	62	22	0		Sunday.		
“ 12......	3.00	1.62	120	39	0	620	260	16	1.45
“ 13......	2.97	2.06	107	22	0	820	520	10	1.38
“ 14......	2.97	3.06	82	19	0	850	120	26	1.22
“ 15......	2.81	3.91	65	15	0	150	260	6	1.17
“ 16......	3.00	4.29	45	18	0	270	340	17	0
“ 17......	3.00	3.86	35	22	0	340	200	13	0
“ 18	3.00	3.47	21	13	0		Sunday.		0
“ 19......	3.00	3.49	18	10	0	180	220	17	0
“ 20......	3.00	3.56	20	8	0	210	180	16	0
“ 21......	3.00	3.58	20	10	0	1 300	650	8	0
“ 22......	2.99	3.73	27	13	0	3 800	360	6	0
“ 23......	3.00	4.00	49	34	0	2 500	700	10	0
“ 24......	3.00	4.05	36	26	0	3 900	630	12	0
“ 25......	2.98	4.06	34	24	0		Sunday.		0
“ 26......	3.00	4.20	21	13	0	700	310	16	0
“ 27......	3.00	4.31	19	11	0	470	250	12	0
“ 28......	2.99	4.40	18	10	0	500	160	18	0
“ 29......	3.01	4.41	17	9	0	360	110	9	0
“ 30......	2.98	4.46	15	8	0	320	310	14	0
“ 31....	Scraped. 1.88 in. of sand removed.		13	..	..	200	100	......	0
Sept. 5......	3.00	0.10	34	4	0	360	950	......	1.04
“ 6......	3.00	0.10	160	3	0	15 000	1 500	190	1.35
“ 7......	3.00	0.09	64	3	0	2 000	260	100	1.20
“ 8......	3.00	0.08	56	4	0		Sunday.		1.04
“ 9......	3.00	0.08	59	3	0	220	180	38	1.04
“ 10......	2.97	0.07	57	3	0	18 000	150	29	1.06
“ 11......	2.98	0.07	65	2	0	2 700	200	37	1.04
“ 12......	2.98	0.08	72	2	0	1 000	125	19	1.04
“ 13......	3.00	0.08	87	3	0	2 300	200	72	1.20
“ 14......	3.00	0.08	72	3	0	2 400	360	36	1.12
“ 15......	3.00	0.08	65	3	0		Sunday.		1.04
“ 16......	3.00	0.08	65	2	0	Lost.	Lost.	38	1.04
“ 17......	3.00	0.08	52	2	0	420	200	38	1.07
“ 18......	3.00	0.08	60	2	0	900	200	17	1.07
“ 19......	2.98	0.08	85	2	0	2 000	220	25	1.12
“ 20......	2.98	0.09	100	2	0	4 200	320	31	1.24
“ 21......	2.99	0.09	120	3	0	1 100	160	19	1.33
“ 22......	3.00	0.09	137	3	0		Sunday.		1.45
“ 23......	3.02	0.09	112	4	0	2 400	190	15	1.41
“ 24......	3.00	0.10	100	4	0	4 000	620	13	1.33
“ 25......	3.00	0.11	432	3	0	56 000	290	7	1.83
“ 26......	2.99	0.11	385	2	0	1 300	950	19	2.34
“ 27......	3.00	0.12	245	4	0	4 000	Lost.	20	1.91
“ 28......	2.98	0.13	127	4	0	15 000	1 000	8	1.54
“ 29......	2.98	0.14	105	4	0		Sunday.		1.34
“ 30	2.99	0.15	115	3	0	Lost.	Lost.	46	1.35
Oct. 1......	3.00	0.15	82	3	0	600	1 700	22	1.24
“ 2......	2.98	0.16	65	3	0	4 400	550	8	1.09
“ 3......	3.00	0.17	59	2	0	900	330	15	1.04
“ 4......	2.99	0.17	55	2	0	850	250	11	1.03
“ 5......	2.99	0.19	59	2	0	2 000	450	25	1.04
“ 6......	2.98	0.20	59	2	0		Sunday.		1.04
“ 7......	2.98	0.21	52	2	0	1 250	2 300	42	1.04
“ 8......	2.97	0.21	54	2	0	11 000	100	15	1.04

TABLE 19.—(*Continued.*)

Date.	SAND FILTER.		TURBIDITY.			BACTERIA.			COAGULANT.
	Rate.	Loss of head.	Applied water.	Effluent, coagulant.	Effluent, sand.	Applied water.	Effluent, coagulant.	Effluent, sand.	Grains, per gallon.
1907.									
Oct. 9......	2.98	0.22	51	2	0	2 000	1 600	7	1.04
" 10......	2.98	0.24	50	2	0	800	Lost.	24	1.04
" 11......	2.98	0.25	47	2	0	2 000	1 200	21	0
" 12......	2.97	0.26	36	3	0	1 200	1 200	19	0
" 13......	2.98	0.27	40	4	0		Sunday.		0
" 14......	2.98	0.29	47	5	0	1 200	830	25	0
" 15	2.99	0.31	41	5	0	900	Lost.	105	0
" 16......	2.99	0.32	35	4	0	Lost.	550	19	0
" 17......	2.98	0.34	30	4	0	550	800	21	0
" 18......	3.00	0.35	25	4	0	260	350	9	0
" 19......	3.00	0.35	25	4	0	750	310	35	0
" 20......	3.00	0.35	20	3	0		Sunday.		0
" 21......	3.00	0.35	19	3	0	480	540	35	0
" 22......	2.99	0.36	18	3	0	230	440	17	0
" 23......	2.99	0.37	15	3	0	250	440	39	0
" 24......	2.98	0.38	15	3	0	300	500	60	0
" 25......	2.99	0.39	15	3	0	450	410	65	0
" 26......	2.99	0.40	15	3	0	450	500	44	0
" 27.....	2.99	0.41	13	2	0		Sunday.		0
" 28......	2.99	0.43	13	2	0	190	500	50	0
" 29......	2.98	0.44	25	2	0	380	60	75	0
" 30......	2.99	0.46	21	2	0	450	180	3	0
" 31......	2.96	0.48	25	3	0	2 300	390	75	0
Nov. 4......	3.00	0.51	125	2	0	......	......	......	0
" 5......	3.00	0.53	185	2	0	6 000	1 600	90	1.70
" 6......	2.99	0.56	170	2	0	5 000	3 900	6	1.70
" 7......	2.99	0.60	100	3	0	14 000	300	9	1.48
" 8......	2.99	0.64	95	3	0	1 900	230	2	1.27
" 9......	2.99	0.70	80	4	0	4 000	2 700	200	0
" 10......	2.99	0.79	67	4	0		Sunday.		0
" 11......	2.99	1.00	52	6	0	1 900	2 000	200	0
" 12......	2.99	1.46	40	9	0	7 500	2 300	160	0
" 13......	2.98	2.09	36	10	0	1 600	1 100	170	0
" 14......	2.99	2.74	42	9	0	2 700	950	130	0
" 15......	2.99	2.98	35	8	0	1 800	800	11	0
" 16......	2.99	3.03	26	8	0	1 100	800	90	0
" 17......	3.00	3.07	20	6	0		Sunday.		0
" 18	3.00	3.09	17	5	0	1 600	700	100	0
" 19......	2.99	3.13	16	4	0	1 300	600	60	0
" 20......	2.99	3.17	45	3	0	6 500	120	120	0
" 21......	2.99	3.22	52	3	0	9 900	1 000	80	0
" 22......	2.99	3.27	65	5	0	10 000	3 200	90	0
" 23......	2.99	3.33	49	8	0	18 000	2 400	100	0
" 24......	2.99	3.41	134	11	0		Sunday.		0
" 25......	2.98	3.54	225	12	1	50 000	2 100	65	1.68
" 26......	2.98	3.68	237	13	1	40 000	2 400	95	1.76
" 27......	2.99	3.96	185	16	1	16 000	2 600	60	1.74
" 28......	2.98	4.29	130	18	1		Holiday.		1.57
" 29......	2.97	4.48	80	19	1	10 000	2 500	65	1.50
" 30......	2.97	4.54	54	15	1	3 800	1 900	85	0
Dec. 6......	Scraped, 1.62 in. of sand removed.								
" 8......	2.97	0.16	12	3	0		Sunday.		1.17
" 9......	2.98	0.16	11	3	0	1 200	410	10	1.17
" 10......	2.98	0.15	12	3	0	800	550	150	1.17
" 11......	2.99	0.15	255	3	0	6 500	600	130	1.52
" 12......	3.00	0.13	212	2	0	48 000	500	130	1.99
" 13......	2.98	0.13	495	4	0	42 000	500	120	2.06
" 14......	2.99	0.14	357	5	0	49 000	750	150	2.12
" 15......	2.99	0.15	157	6	0		Sunday.		1.69

TABLE 19.—(*Continued.*)

Date.	Sand filter.		Turbidity.			Bacteria.			Coagulant.
	Rate.	Loss of head.	Applied water.	Effluent, coagulant.	Effluent, sand.	Applied water.	Effluent, coagulant.	Effluent, sand.	Grains, per gallon.
1907.									
Dec. 16.....	2.98	0.16	90	9	0	19 000	900	20	1.28
“ 17.....	2.98	0.20	70	12	0	21 000	400	170	1.17
“ 18.....	2.98	0.24	49	12	1	6 500	7 000	350	1.17
“ 19.....	2.98	0.29	39	9	1	Lost.	Lost.	Lost.	1.17
“ 20.....	2.98	0.36	42	7	1	“	“	“	1.17
“ 21.....	2.97	0.45	26	5	0	“	“	“	1.17
“ 22.....	2.98	0.57	20	4	0		Sunday.		1.17
“ 23.....	2.98	0.71	34	3	0	1 400	1 300	220	1.17
“ 24.....	2.98	0.83	195	2	0	9 000	1 000	140	1.49
“ 25.....	2.98	0.97	445	2	0		Holiday.		2.43
“ 26.....	2.98	1.11	370	2	0	51 000	1 000	39	2.15
“ 27.....	2.98	1.27	245	3	0	55 000	1 600	70	1.91
“ 28.....	2.98	1.40	102	4	0	10 000	1 000	80	1.50
“ 29.....	2.98	1.60	75	8	0		Sunday.		1.21
“ 30.....	2.97	1.85	56	3	0	4 400	700	80	1.17
“ 31.....	2.98	2.07	39	2	0	14 000	1 200	65	1.17
1908.									
Jan. 1.....	2.99	2.11	31	2	0		Holiday.		1.17
“ 2.....	2.98	2.17	39	2	0	4 400	700	19	1.17
“ 3.....	2.98	2.26	36	2	0	3 100	1 000	13	1.17
“ 4.....	2.98	2.34	32	2	0	2 400	550	19	1.17
“ 5.....	2.98	2.41	26	2	0		Sunday.		1.17
“ 6.....	2.98	2.49	20	2	0	600	230	18	1.17
“ 7.....	2.98	2.58	20	2	0	1 100	370	12	1.17
“ 8.....	2.99	2.61	22	2	0	1 900	1 100	20	1.17
“ 9.....	2.99	2.63	45	2	0	13 000	1 200	22	1.21
“ 10.....	2.98	2.67	70	2	0	10 000	700	16	1.17
“ 11.....	2.98	2.72	56	2	0	16 000	1 200	11	1.17
“ 12.....	2.98	2.78	40	2	0		Sunday.		1.17
“ 13.....	2.98	2.84	110	2	0	8 500	90	6	1.27
“ 14.....	2.98	2.95	210	2	0	16 000	150	23	1.56
“ 15.....	2.98	3.07	325	3	0	24 000	1 100	19	1.92
“ 16.....	2.98	3.23	360	5	6	28 000	1 000	14	2.10
“ 17.....	2.97	3.73	242	5	0	65 000	490	23	1.91
“ 18.....	2.98	4.42	137	6	0	7 000	1 600	14	1.66
“ 19.....	2.99	4.75	117	5	0		Sunday.		1.50
“ 21.....	Scraped, 1.45 in. of sand removed.								
“ 23.....	3.00	0.14	40	3	0	......	......	......	1.17
“ 24.....	3.00	0.14	40	3	0	2 300	550	55	1.17
“ 25.....	3.00	0.13	39	3	0	1 100	850	95	0
“ 26.....	3.00	0.13	32	3	0		Sunday.		0
“ 27.....	3.00	0.13	32	2	0	300	280	60	0
“ 28.....	2.99	0.15	45	3	0	1 200	700	70	0
“ 29.....	2.99	0.20	60	6	1	1 000	900	75	0
“ 30.....	2.99	0.24	57	8	1	1 400	650	50	0
“ 31.....	2.99	0.30	42	6	1	1 100	600	36	0
Feb. 1......	2.99	0.34	39	5	1	750	50	25	0
“ 2......	2.99	0.41	27	4	1		Sunday.		0
“ 3......	2.99	0.51	29	3	0	1 300	220	16	0
“ 4......	2.99	0.56	25	3	0	600	370	10	0
“ 5......	2.99	0.58	24	4	0	750	700	21	0
“ 6......	2.99	0.61	20	6	0	2 000	650	4	0
“ 7......	3.00	0.64	17	8	1	......	410	26	0
“ 8......	2.99	0.66	15	8	1	900	160	42	0
“ 9......	3.00	0.67	14	8	1		Sunday.		0
“ 10......	2.99	0.67	11	8	1	850	450	18	0
“ 11......	3.00	0.66	10	7	1	1 000	600	26	0
“ 12......	3.01	0.64	8	6	1	750	350	16	0
“ 13......	3.00	0.62	9	5	1	700	120	10	0

TABLE 19.—(*Continued.*)

Date.	SAND FILTER.		TURBIDITY.			BACTERIA.			COAGULANT.
	Rates.	Loss of head.	Applied water.	Effluent, coagulant.	Effluent, sand.	Applied water.	Effluent, coagulant.	Effluent, sand.	Grains, per gallon.
1908.									
Feb. 14......	3.00	0.61	9	5	1	1 200	950	43	0
" 15......	3.00	0.60	61	5	1	5 500	1 000	23	0
" 16......	3.00	0.60	80	6	1		Sunday.		0
" 17......	3.00	0.62	80	14	1	33 000	6 100	36	0
" 18......	2.99	0.67	130	20	1	......	2 000	11	0
" 19......	2.99	0.76	320	18	2	28 000	9 000	120	0
" 20......	2.99	0.83	177	15	2	22 000	8 500	190	0
" 29......	3.00	0.85	123	8	1	......	......	......	0
Mar. 1......	3.00	0.87	97	9	1		Sunday.		0
" 2......	2.99	0.92	82	13	1	8 000	4 400	50	0
" 3	2.98	0.96	87	19	1	11 000	2 100	26	0
" 4......	2.99	1.02	67	21	1	6 000	4 700	7	0
" 5......	2.99	1.08	59	25	1	4 400	10 000	36	0
" 6......	2.99	1.15	72	25	2	7 000	7 400	50	0
" 7......	2.98	1.21	82	25	2	9 500	6 500	28	0
" 8......	2.99	1.26	92	29	2		Sunday.		0
" 9......	2.99	1.30	125	34	2	11 000	4 800	25	0
" 10......	2.99	1.35	142	39	2	8 500	1 200	23	0
" 11......	2.99	1.39	155	35	2	6 500	2 400	20	0
" 12......	2.99	1.42	135	29	2	5 900	1 500	11	0
" 13......	2.99	1.46	122	19	2	1 900	1 100	12	0
" 14......	2.99	1.47	97	12	1	1 800	700	6	0
" 15......	2.99	1.48	77	8	1		Sunday.		0
" 16......	3.00	1.52	65	6	0	1 400	700	8	0
" 17......	2.99	1.66	59	7	0	900	800	11	0
" 18......	2.99	1.72	67	11	1	1 000	650	8	0
" 19......	2.99	1.75	60	24	1	.....	600	18	0
" 20......	2.99	1.81	57	25	1	1 300	750	20	0
" 21......	2.99	1.89	67	22	1	800	480	18	0
" 22......	2.99	1.95	80	21	1		Sunday.		0
" 23......	3.00	2.00	90	26	1	4 600	440	19	0
" 24......	2.98	2.06	82	32	1	2 500	1 200	10	0
" 25......	2.99	2.17	67	39	1	1 600	650	20	0
" 26......	2.99	2.24	60	36	1	550	410	7	0
" 27......	2.99	2.29	59	30	1	950	900	29	0
" 28......	3.00	2.32	51	21	1	650	250	42	0
" 29.....	2.99	2.35	31	18	1		Sunday.		0
" 30......	3.00	2.38	30	14	1	500	650	28	0
" 31......	2.99	2.43	39	9	1	750	290	30	0
Apr. 1......	2 99	2.50	44	7	1	750	390	32	0
" 2......	2.99	2.58	42	8	1	1 100	280	47	0
" 3......	2.99	2.65	41	11	1	1 500	550	70	0
" 4......	2.99	2.74	54	12	1	700	380	4	0
" 5......	3.00	2.82	50	12	1		Sunday.		0
" 6......	2.99	2.88	41	14	1	440	150	4	0
" 7......	2.99	2.98	35	13	1	650	270	42	0
" 8......	2.98	3.15	39	11	1	550	210	65	0
" 9......	2.99	3.35	40	8	1	390	160	95	0
" 10......	2.98	3.50	40	8	1	500	130	130	0
" 11......	2.99	3.65	45	7	0	430	145	100	0
" 12	2.99	3.79	52	5	0		Sunday.		0
" 13......	2.99	3.92	50	4	0	490	160	80	0
" 14......	2.99	4.05	45	4	0	550	170	90	0
" 15......	2.99	4.16	45	3	0	420	160	12	0
" 16......	....	4.24	45	3	0	360	130	90	0
" 21......	Scraped, 0.12 in. of sand removed.								
" 23......	....	0.13	25	2	0	140	140	......	0
" 24	3.00	0.12	21	2	0	200	Lost.	150	0
" 25......	3.00	0.10	20	2	0	85	550	45	0

TABLE 19.—(*Continued.*)

Date.	SAND FILTER.		TURBIDITY.			BACTERIA.			COAGULANT.
	Rate.	Loss of head.	Applied water.	Effluent, coagulant.	Effluent, sand.	Applied water.	Effluent, coagulant.	Effluent, sand.	Grains, per gallon.
1908.									
Apr. 26......	3.00	0.10	24	3	0		Sunday.		0
" 27......	3.00	0.10	18	3	0	95	850	50	0
" 28......	3.00	0.10	20	3	0	70	220	48	0
" 29......	3.00	0.09	24	3	0	110	210	95	0
" 30......	3.00	0.09	21	3	0	70	140	29	0
May 1......	3.00	0.09	32	3	0	130	210	65	0
" 2......	3.00	0.09	26	3	0	140	140	55	0
" 3......	3.00	0.11	22	5	0		Sunday.		0
" 4......	3.00	0.11	19	4	0	85	210	75	0
" 5......	3.00	0.11	18	4	0	130	150	48	0
" 6......	2.99	0.12	18	3	0	230	430	50	0
" 7......	3.00	0.13	19	3	0	160	90	40	0
" 8......	3.00	0.14	19	3	0	375	425	7	0
" 9......	2.99	0.14	18	3	0	1 200	180	6	0
" 10......	3.00	0.14	30	3	0		Sunday.		0
" 11......	3.00	0.13	60	3	0	2 800	150	12	0
" 12......	3.00	0.13	70	3	0	2 900	225	26	0
" 13......	3.00	0.13	66	7	0	1 800	450	53	0
" 14......	3.00	0.14	45	9	0	2 700	550	10	0
" 15......	2.99	0.14	39	7	0	950	300	65	0
" 16......	2.99	0.22	49	6	0	800	250	49	0
" 17......	2.99	0.33	46	4	0		Sunday.		0
" 18......	2.99	0.44	31	3	0	700	1 700	80	0
" 19......	2.98	0.62	36	3	0	375	950	53	0
" 20......	2.99	0.75	41	3	0	425	700	46	0
" 21......	2.99	0.89	31	4	0	300	600	6	0
" 22......	2.99	1.01	50	5	0	950	230	17	0
" 23......	2.99	1.12	127	5	0	2 400	32	28	0
" 24......	2.99	1.20	110	6	0		Sunday.		0
" 25......	2.99	1.24	90	9	0	600	220	9	0
" 26......	2.98	1.31	135	11	0	3 200	150	17	0
" 27......	2.97	1.54	110	12	0	1 450	175	8	0
" 28......	2.97	1.81	90	10	0	1 000	132	7	0
" 29......	2.97	2.08	70	7	0	1 100	230	8	0
" 30......	2.97	2.36	50	5	0		Holiday.		0
" 31......	2.98	2.63	34	4	0		Sunday.		0
June 1......	2.98	2.77	35	2	0	......	......	......	0
" 2......	2.98	2.84	39	2	0	......	......	......	0
" 3......	2.98	3.02	35	3	0	......	......	......	0
" 4......	3.00	3.01	30	4	0	......	......	......	0
" 5......	3.00	2.97	30	5	0	......	......	......	0
" 6......	3.01	2.81	27	5	0	......	......	......	0
" 7......	3.01	2.62	22	5	0	......	......	......	0
" 8......	3.01	2.38	20	4	0	......	......	......	0
" 9......	3.00	2.19	20	3	0	......	......	......	0
" 10......	3.01	2.02	17	3	0	......	......	......	0
" 11......	2.99	1.89	12	3	0	......	......	......	0
" 12......	2.98	1.92	11	2	0	......	......	......	0
" 13......	2.98	1.99	36	2	0	......	......	......	0
" 14......	2.98	2.08	39	2	0	......	......	......	0
" 15......	2.98	2.25	25	4	0	......	......	......	0
" 16......	2.98	2.54	34	5	0	......	......	......	0
" 17......	2.97	2.85	64	5	0	......	......	......	0
" 18......	2.97	3.20	57	5	0	......	......	......	0
" 19......	2.98	3.47	46	7	0	......	......	......	0
" 20......	2.98	3.73	37	8	0	......	......	......	0
" 21......	2.97	4.10	29	8	0	......	......	......	0
" 22......	2.97	4.44	25	6	0	......	......	......	0
" 23......	2.99	4.61	25	5	0	......	......	......	0

TABLE 19.—(*Continued.*)

Date.	SAND FILTER.		TURBIDITY.			BACTERIA.			COAGULANT.
	Rate.	Loss of head.	Applied water.	Effluent, coagulant.	Effluent, sand.	Applied water.	Effluent, coagulant.	Effluent, sand.	Grains, per gallon.
1908.									
June 26......	3.01	0.09	15	2	0	......	.....	......	0
" 27......	3.00	0.09	12	2	0	......	......	......	0
" 28......	3.00	0.09	9	2	0	......	......	......	0
" 29......	3.00	0.08	8	2	0	......	......	.....	0
" 30......	3.00	0.07	10	2	0	......	......	......	0
July 1......	3.00	0.07	6	2	0	80	75	3	0
" 2......	3.00	0.07	8	2	0	290	20	3	0
" 3......	3.00	0.07	8	2	0	350	140	4	0
" 4......	3.00	0.07	9	2	0		Holiday.		
" 5......	3.00	0.07	10	2	0		Sunday.		
" 6......	3.00	0.07	9	2	0	300	52	4	0
" 7......	3.00	0.07	8	2	0	110	35	2	0
" 8......	3.00	0.07	9	2	0	85	105	2	0
" 9......	3.00	0.07	8	2	0	85	80	3	0
" 10......	....	....	..	..	..	200	65	1	0
" 11......	3.00	0.08	12	2	0	145	95	11	0
" 12......	3.00	0.08	11	2	0		Sunday.		0
" 13......	3.00	0.08	10	2	0	115	105	7	0
" 14......	3.00	0.09	16	2	0	300	34	1	0
" 15......	3.00	0.09	17	2	0	180	165	3	0
" 16......	3.00	0.10	14	2	0	100	95	2	0
" 17......	2.99	0.10	10	2	0	65	65	1	0
" 18......	3.00	0.11	11	2	0	38	200	24	0
" 19......	3.00	0.11	12	2	0		Sunday.		
" 20......	3.00	0.12	10	2	0	95	31	1	0
" 21......	3.00	0.12	10	2	0	70	100	2	0
" 22......	3.00	0.13	13	2	0	450	13	4	0
" 23......	2.99	0.13	54	2	0	650	325	4	0
" 24......	2.99	0.14	305	2	0	1 650	325	..	0
" 25......	3.00	0.15	330	4	0	2 600	55	2	0
" 26......	3.00	0.15	290	9	0		Sunday.		
" 27......	3.00	0.16	335	11	0	35 000	1 200	6	0
" 28......	2.99	0.17	170	10	0	1 200	675	6	0
" 29......	3.00	0.17	180	8	0	2 000	270	11	0
" 30......	2.99	0.18	237	7	0	800	190	2	0
" 31......	3.00	0.19	250	6	0	1 000	310	6	0

TABLE 20.—SUMMARY OF RESULTS OF EXPERIMENTAL FILTERS.

Filter number	1	2	3	4	5	6
Number of runs	3	6	11	12	25	28
Rate, million gallons per acre per day:						
Maximum	1.35	3.95	7.96	12.60	37.5	118.9
Minimum	0.62	2.30	3.73	5.77	6.68	7.1
Average	1.06	3.26	6.69	10.17	26.1	38.54
Length of run, in days:						
Maximum	233.5	150.5	75.2	90.9	48.71	39.83
Minimum	181.7	42.0	14.5	10.1	0.67	0.62
Average	206.4	109.6	48.89	40.5	14.41	12.61
Million gallons filtered per acre per run:						
Maximum	242.61	484.46	534.67	960.72	1 463.35	1 022.27
Minimum	202.60	135.66	93.79	92.57	19.53	53.32
Average	218.58	302.82	326.76	417.23	374.14	361.92
Cubic yards of sand removed per acre at end of each run:						
Maximum	269	269	672	1 612	2 420	3 360
Minimum	269	134	101	134	134	101
Average	269	213	272	392	583	635
Cubic yards of sand removed per acre per million gallons filtered	1.23	0.70	0.83	0.94	1.55	1.72
Average initial loss of head	0.07	0.19	0.51	0.78	3.88	5.38
Turbidity, influent:						
Maximum	120	120	120	120	90	100
Minimum	2	2	2	2	2	2
Average	20	20	21	22	18	19
Turbidity, effluent:						
Maximum	11	13	17	18	30	30
Minimum	0	0	0	0	0	0
Average	1	1	2	2	4	3
Percentage, reduction	95.0	95.0	90.5	90.9	77.8	84.3
Bacteria, influent:						
Maximum	180 000	180 000	180 000	110 000	180 000	37 500
Minimum	22	20	22	20	25	24
Average	4 800	5 100	4 500	4 200	6 900	5 900
Bacteria, effluent:						
Maximum	4 000	1 300	3 200	5 400	12 800	2 400
Minimum	2	3	1	1	2	2
Average	160	85	110	120	190	180
Percentage, reduction	96.7	98.3	97.6	97.3	97.3	97.0
Number of samples examined for *bacillus coli* in influent:						
10 c.c.	549	478	476	436	325	336
1 c.c.	560	492	486	445	335	342
0.1 c.c.	525	459	452	413	318	317
0.01 c.c.	511	443	439	405	308	304
0.001 c.c.	500	434	429	394	299	294
Number of samples examined for *bacillus coli* in effluent:						
10 c.c.	512	452	454	404	296	309
1 c.c.	513	454	457	406	299	311
0.1 c.c.	480	419	426	383	271	286
0.01 c.c.	478	406	410	367	261	276
0.001 c.c.	478	406	410	367	261	276

TABLE 20.—(*Continued.*)

Filter number	1	2	3	4	5	6
Number of runs	3	6	11	12	25	28
Number samples positive, influent:						
10 c.c.	226	211	201	258	136	152
1 c.c.	127	123	116	108	81	93
0.1 c.c.	55	59	54	51	43	42
0.01 c.c.	26	34	33	33	27	25
0.001 c.c.	6	6	5	6	3	3
Number samples positive, effluent:						
10 c.c.	100	109	134	98	94	106
1 c.c.	51	61	55	56	46	50
0.1 c.c.	9	13	16	16	4	13
0.01 c.c.	0	0	0	0	0	0
0.001 c.c.	0	0	0	0	0	0
Percentage of samples showing *bacillus coli* in influent:						
10 c.c.	41.2	44.2	42.2	59.2	41.9	45.2
1 c.c.	22.7	25.0	23.9	24.3	24.2	27.2
0.1 c.c.	10.5	12.8	11.9	12.3	13.5	13.2
0.01 c.c.	5.1	7.7	7.5	8.2	8.8	8.2
0.001 c.c.	1.2	1.4	1.2	1.5	1.0	1.0
Percentage of samples showing *bacillus coli* in effluent:						
10 c.c.	19.5	24.1	29.5	24.2	31.7	34.3
1 c.c.	10.0	13.4	12.0	13.8	15.4	16.1
0.1 c.c.	1.9	3.1	3.8	4.2	1.5	4.5
0.01 c.c.	0	0	0	0	0	0
0.001 c.c.	0	0	0	0	0	0
Cost per million gallons for sand handling	$0.43	$0.25	$0.29	$0.33	$0.54	$0.60
Interest charges at 3%	6.85	2.25	1.12	0.73	0.32	0.22
Total	7.28	2.50	1.41	1.06	0.86	0.82

Coli tests presumptive.

Vol. XXXVI. DECEMBER, 1910. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE WATER-WORKS AND SEWERAGE OF MONTERREY, N. L., MEXICO.

BY GEORGE ROBERT GRAHAM CONWAY, M. AM. SOC. C. E.

TO BE PRESENTED FEBRUARY 1ST, 1911.

INTRODUCTORY.

Monterrey, the Capital of the State of Nuevo León, Mexico, is built on the site of the old village of Santa Lucía de León, which was established in 1583 by the Governor of the Kingdom of León, Don Luis Carabajal. Four years later Carabajal was imprisoned by the Inquisition, and the village of Santa Lucía was abandoned by its few inhabitants.

In 1596, Captain Diego Montemayor, a resident of Saltillo, in the adjoining State, wishing to render a service to his king, Philip II of Spain, assembled his friends, and on September 20th of that year, proceeded to establish a town on the site of the old village on the northern side of the principal spring at the place. The town was named "Nuestra Señora de Monterrey" (Our Lady of Monterrey), after the Count of Monterrey (Ojos de Santa Lucía y Valle de Extremadura), the ruling Governor of New Spain, as Mexico was then called.

NOTE.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

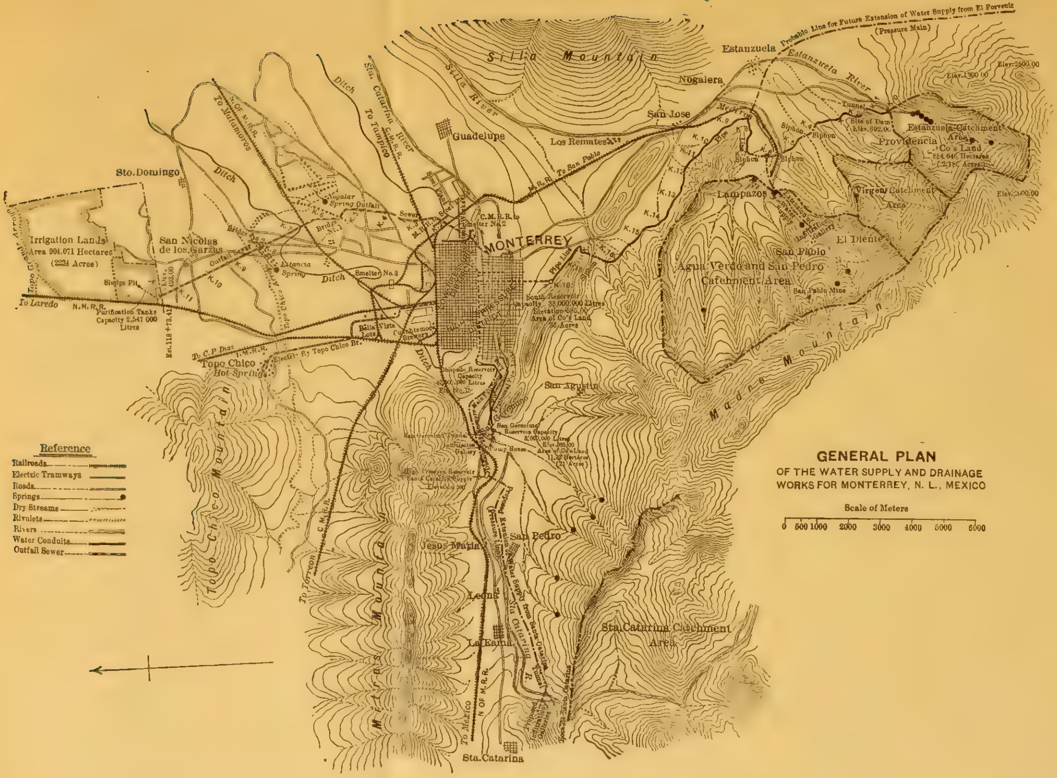
Monterrey is approximately in the center of the State of Nuevo León, 1° 12′ west of Mexico City, and in latitude 26° 40′ N. It is a distributing railway center on the main line of the National Railroad, 270 km. from the Rio Grande at Laredo, 1 022 km. from Mexico, and 520 km. from Tampico by the Mexican Central Railway. It is the center of many large industries, and is the second largest manufacturing city in the Republic.

THE CONCESSION.

The works described in this paper were carried out under a guaranteed concession granted by His Excellency, General Bernardo Reyes, Governor of the State of Nuevo León, to Messrs. James D. Stocker and William Walker, of Scranton, Pa. The concession is dated October 19th, 1904, and is for 99 years from that date; the works for a complete water and drainage system were to be finished in 3 years from the time of their commencement. Before the works were designed and begun, the concession was acquired by Mr. William Mackenzie, of the firm of Mackenzie, Mann and Company, Limited, of Toronto, Ont., Canada, who, on May 4th, 1906, organized the Monterrey Water-Works and Sewerage Company, Limited (Compañía de Servicio de Agua y Drenaje de Monterrey, S. A.), under the laws of the Dominion of Canada, of which company he is President. Mr. Mackenzie is also President of the Monterrey Railway, Light, and Power Company, Limited, which was constructing the street railways of Monterrey concurrently with the water-works. Under the provisions of the concession, the Government appointed a Financial Interventor, who had authority to examine and check the company's expenditures, and also a Technical Inspector to examine and report on the construction. The duties of these officials also apply to the operation of the system when the construction is finished. The Government has the right, after the system has been operated 40 years, to purchase the entire property, subject to 6 months' notice, for a sum equal to $16\frac{2}{3}$ times the average annual net proceeds during the 3 preceding years. This right may be exercised at the end of 40 years, or at the end of any 10-year period thereafter, up to 99 years from the commencement of operations.

GEOLOGY AND TOPOGRAPHY.

Monterrey lies in a plain at the foot of the Eastern Sierra Madre Mountains which constitute the eastern margin of the Mexican Cor-



GENERAL PLAN
OF THE WATER SUPPLY AND DRAINAGE
WORKS FOR MONTERREY, N. L., MEXICO

dilleran Plateau, and is surrounded by the magnificent mountains of that group, among the most notable of which are the beautiful Mitra and Silla Mountains. In the neighborhood of Monterrey these mountains attain heights of from 2 000 to 2 400 m., and are noted for their broken and jagged sky-lines. The leading geological characteristics of the district are the uplifted limestones of the older cretaceous age which form the main mass of the mountains.

Primarily, the mountains are compressional folds which, in the Sierra Madre, near Monterrey, are close and vertically compressed.* The drainage areas of the Santa Catarina River, which flows through Monterrey, and of the Estanzuela and Silla Rivers, its tributaries, are of limestone and shale; originally the shales were above the limestone, but the convulsion which formed the Sierra Madre as an anticlinal fold, left the originally horizontal strata standing nearly upright, and subsequent erosion in the upper part of the anticline has exposed nearly vertical strata in many places. The limestone being hard and resisting erosion, there is generally, along the line of contact, an abrupt drop vertically on the face of the limestone to the shale below. In many places this abrupt drop is broken by a limestone talus, but the line of contact can generally be traced. Mining operations in these mountains have revealed the presence of large caves at a considerable elevation, many of which contain large reservoirs of water delivered to them through numerous faults. The river valleys are formed of masses of limestone conglomerate and coarse gravels, re-cemented in many cases by the lime deposits of the flowing waters. One of the chief characteristics of the subsoil of Monterrey itself is a local rock called "sillar," which is a superficial deposit of carbonate of lime from the evaporated waters. In some places the "sillar" is largely mixed with a conglomerate called "tepetate," or "impure sillar."

Topographically, the region around Monterrey is distinguished by the drainage area of the River Santa Catarina, which rises in the Sierra Madre near the Laguna de Sanchez, at an elevation of 1 850 m., as shown on Plate CLXXX. From this Laguna it follows a tortuous course between precipitous mountains through the Boca of Santa Catarina to Monterrey, for a distance of 90 km., eventually finding its way to the San Juan River, a tributary of the Rio Grande. Throughout its course it disappears, flows underground, and again appears; and, except in flood time, it has a subsurface flow for a distance of 16 km. above the city. In the Cañon of Santa Catarina it appears at the surface, having a normal flow of about 1 415 liters (50 cu. ft.) per sec., and its waters at that point are divided into two parts and carried into irrigation canals. The drainage area of the river above Monterrey is 1 410 sq. km., and its bed at Monterrey is between 518 and 545 m. above sea level.

---

* *Transactions*, Am. Inst. Min. Engrs., Vol. XXXII, (1902), pp. 163-178.

Southward from Monterrey the country rises along the valley of the Silla for a distance of 19 km., where the Silla is separated from the San Juan by a low divide, the former flowing northward to Monterrey and the latter southeastward toward Allende. The Silla Valley is bounded on the east and west by the steep ranges of the Silla and Sierra Madre Mountains. The floor of this valley is gently rolling, but is cut by many arroyos which carry little or no water during the greater part of the year. The chief feeder of the Silla River is the Estanzuela, a stream which derives its waters from several springs coming to the surface near the line of contact between the limestone and the shale, at elevations of about 800 and 900 m.* above datum. The water-shed of this stream is rich with abundant vegetation due to the precipitation being greater than on the Santa Catarina water-shed. To the south of the divide the country is well wooded, and El Porvenir, 35 km. from Monterrey, is the garden spot of the State of Nuevo León. Here the rainfall is much greater than at any other point near Monterrey, and there are many streams which are used for irrigation purposes. Monterrey is built on a plain, chiefly on the north side of the Santa Catarina River. This plain has a general fall toward the northeast, and beyond the city it slopes gently northward for several miles toward the Topo Grande River, and then southeastward to join the great coastal plain of the Gulf of Mexico. The general elevation of the city lies between the 519- and 550-m. contours. The Plaza Zaragoza, in the center of the city, is 533.90 m. above sea level; the elevation of the highest part of the city, at the western boundary, is 550.05 m., and of the lowest part, at the northeastern boundary, 518.0 m. above sea level.

---

* Throughout this paper datum refers to the height in meters above the mean sea level of the Gulf of Mexico at the Port of Tampico.

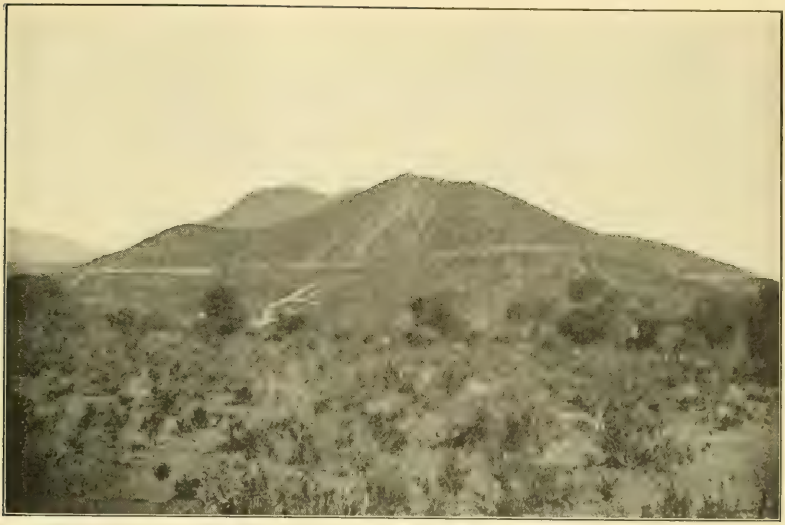


FIG. 1.—GENERAL VIEW OF LINE, ESTANZUELA AQUEDUCT.

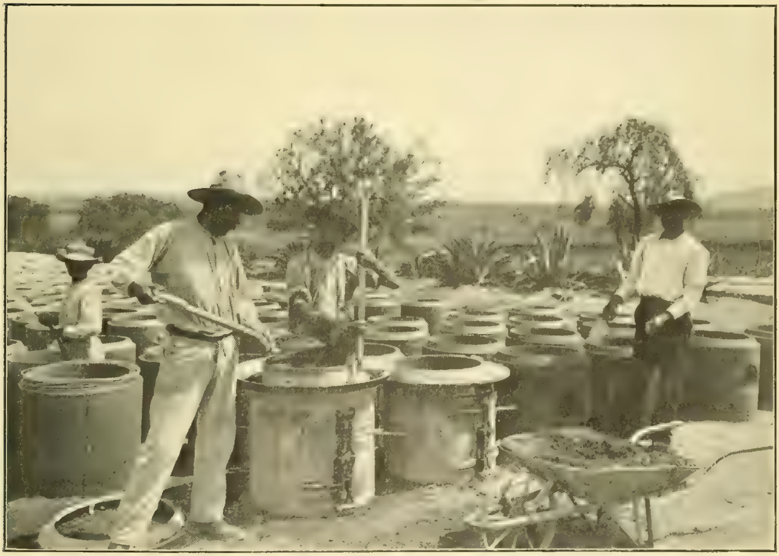


FIG. 2.—STEEL FORMS FOR MOULDING CONCRETE TUBES, ESTANZUELA AQUEDUCT.

POPULATION, AREA, AND MORTALITY.

The population of Monterrey has increased as follows:

Census of	1851	14 621
" "	1861	26 000
" "	1871	33 811
" "	1881	39 456
" "	1891	41 154
" "	1901	73 508
(Estimated)	1909	86 000 to 90 000

The greatest progress, it will be noted, was between 1891-1901, with an increase of more than 22 000 in 10 years. In designing the new works, provision has been made for the future requirements of a city of 200 000 persons.

The actual area within the city limits proper is 960.5 hectares (2 374 acres), forming the area to be provided with water and drainage, but the municipal district extends to many surrounding suburbs, and covers an area of 33 758 hectares (83 426 acres).

TABLE 1.—POPULATION AND DEATH RATE OF MONTERREY, N. L., MEXICO, FROM 1901 TO 1909, INCLUSIVE.

Year.	Population.	Deaths from all causes.	Rate per 1 000.	Deaths from typhoid fever.													Deaths from typhoid fever per year per 100 000 population.
				Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total for year.	
Census 1901..	73 508	2 965	40.3	0	2	1	3	4	3	6	6	3	6	4	2	40	54
Estimated 1902..	74 500	3 338	44.8	1	4	2	3	6	5	3	1	1	2	3	5	36	48
" 1903..	76 000	3 825	50.3	3	2	4	1	0	5	3	5	6	16	3	1	49	64
" 1904..	77 500	2 905	37.4	0	1	1	5	3	3	3	4	1	5	1	0	27	35
" 1905..	79 000	2 951	37.4	2	0	0	3	3	7	6	3	2	7	2	2	37	47
" 1906..	80 000	2 935	36.7	1	2	1	3	3	6	5	3	2	1	2	3	32	40
" 1907..	82 500	3 269	39.6	4	6	3	3	5	6	4	4	9	3	0	3	50	61
" 1908..	84 000	3 188	37.9	5	2	5	3	8	5	9	7	2	7	4	0	57	68
" 1909..	86 000	*3 477	40.4	5	1	4	5	13	11	15	12	6	8	3	4	87	101

* Excluding deaths due to drowning in the great flood of August 27th and 28th.

Table 1 gives particulars of the death rate for 1901 to 1909, inclusive, and data relative to the mortality due to typhoid fever. The high death rate is caused by the excessive infantile mortality, which is so prevalent throughout the whole of Mexico. The climatic condition of Monterrey, with its exceptionally healthy subsoil, ought to make it one of the healthiest of cities, if proper care were taken to enforce sanitary laws. The data regarding typhoid mortality are probably understated, as they were compiled by the writer, in the absence of any official publications, from the actual death certificates, but no special care is taken by the authorities to insure accuracy in such certificates. Attention is called to the typhoid rate in May, June, July, and August, 1909; this high rate coincides with a scarcity of rainfall and the greatest period of drought experienced in 30 years, and immediately precedes the great flood of August 27th. It was probably due to the lowering of the ground-water throughout the city and the consequent contamination of the private wells, which were largely in use during that time. Throughout the city the wells are sunk to a depth of about 12 or 15 m., in order to reach the subterranean waters, and the cesspools are often in dangerous proximity to them and at a much higher level. The nature of the subsoil, which is often much fissured and open in the conglomerate and sillar stratas, would make the passage of contamination an easy matter, and this alone would account for a high mortality due to water-borne diseases.

Rainfall and Temperature.

The precipitation records of Monterrey and its neighborhood are very meager, and cannot be relied on for a longer period than from 1894 to 1909, inclusive. The records are available from 1886, but in the early years there are many apparent discrepancies, and they are probably inaccurate. The average rainfall for the 15 years (1894-1908) is 21.94 in.; the driest years for this period are as follows: 1894, 14.14 in.; 1902, 15.29 in.; 1907, 15.23 in.; 1908, 15.11 in. Assuming the early records to be correct, the average rainfall for the period, 1886-1908, would be 19.86 in.

At Saltillo, which is 50 miles due southwest, at an elevation of about 1 520 m. above sea level, the average rainfall for the 23 years, 1884-1908, inclusive, is given as 21 in. The maximum year was 1889, with 33½ in., and the minimum 1903, with 7½ in.

At Carmen, in the State of Tamaulipas, 144 km. southwest of Monterrey, at an elevation of about 310 m. above sea level, the average fall for 12 years is 24.70 in., the maximum year being 1897, with a fall of 34.09 in., and the minimum year, 1905, with 13.41 in.

Fig. 1 shows the annual variation of rainfall at Monterrey for 1894-1909. Fig. 2 shows the monthly variation during the same period, and gives the minimum, average, and maximum for each month.

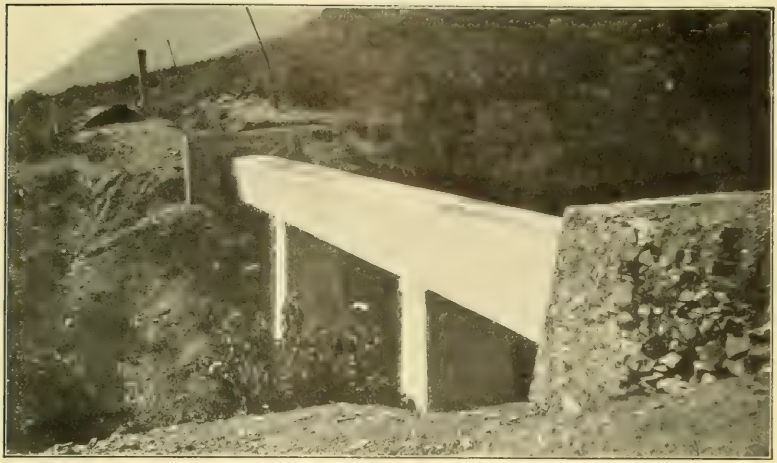


FIG. 1.—TYPICAL REINFORCED CONCRETE GIRDER BRIDGE. ESTANZUELA AQUEDUCT.

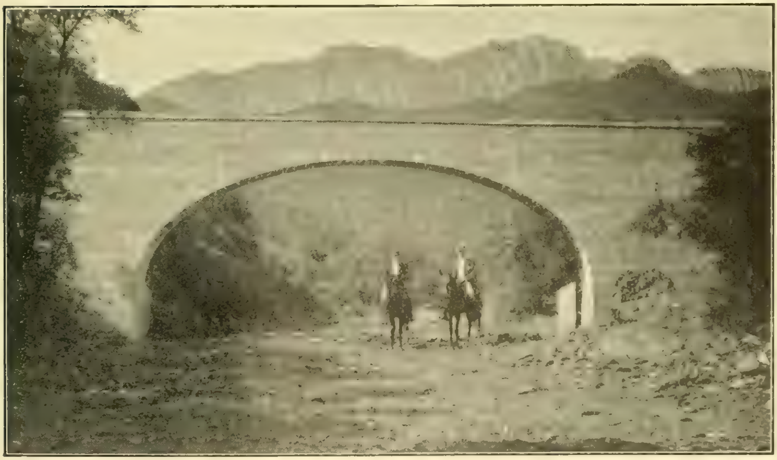


FIG. 2.—ELLIPTICAL ARCH BRIDGE CARRYING ESTANZUELA AQUEDUCT.

From these diagrams it will be seen that the months of least rainfall are December, January, February, and March, with averages of 0.66, 0.59, 0.79, and 0.93 in., respectively. The months of greatest rainfall are August, with an average of 4.39 in., and September with 4.87 in. The maximum in any month prior to 1909 was 16.75 in., during September, 1904.

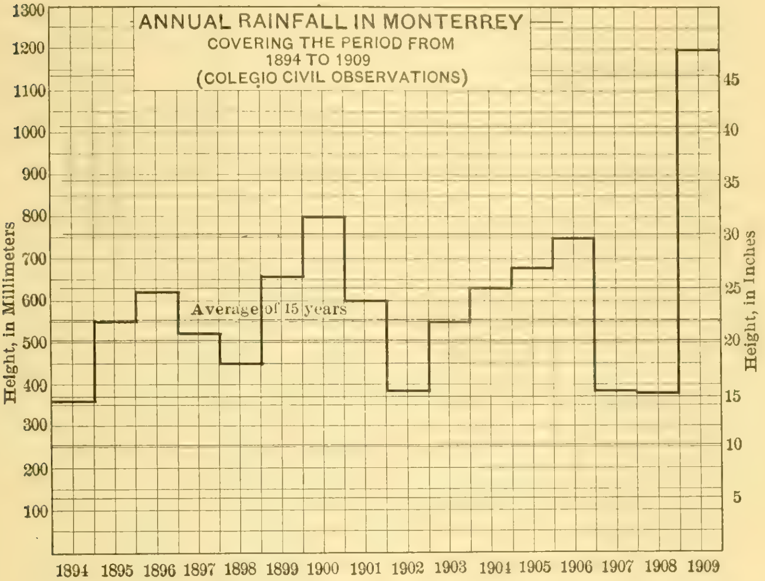


FIG. 1.

Rainfall in 1909.—The rainfall in 1909 was unprecedented, causing the disastrous flood in the Santa Catarina River, which will be referred to when describing the works. Fig. 3 shows the monthly rainfall for 1906 to 1909, inclusive, and has been plotted to show the variation of rainfall prior to the great precipitation of August, 1909. In that month there were two heavy falls, one beginning at midnight on August 9th, and during the following 42 hours a fall of 13.28 in. was recorded by the gauge at the Water-Works Company's general offices, 10.20 in. of which fell during the first 24 hours. From 6 P. M. to 11 P. M., on August 10th, 5.019 in. were recorded, or an average of 1 in. per hour.

After 13 dry days, another rainstorm began, at 4 P. M., on August

25th, and continued more or less intermittently until August 29th. During this 98-hour period there was an additional fall of 21.61 in., 11.27 in. falling in 24 hours.

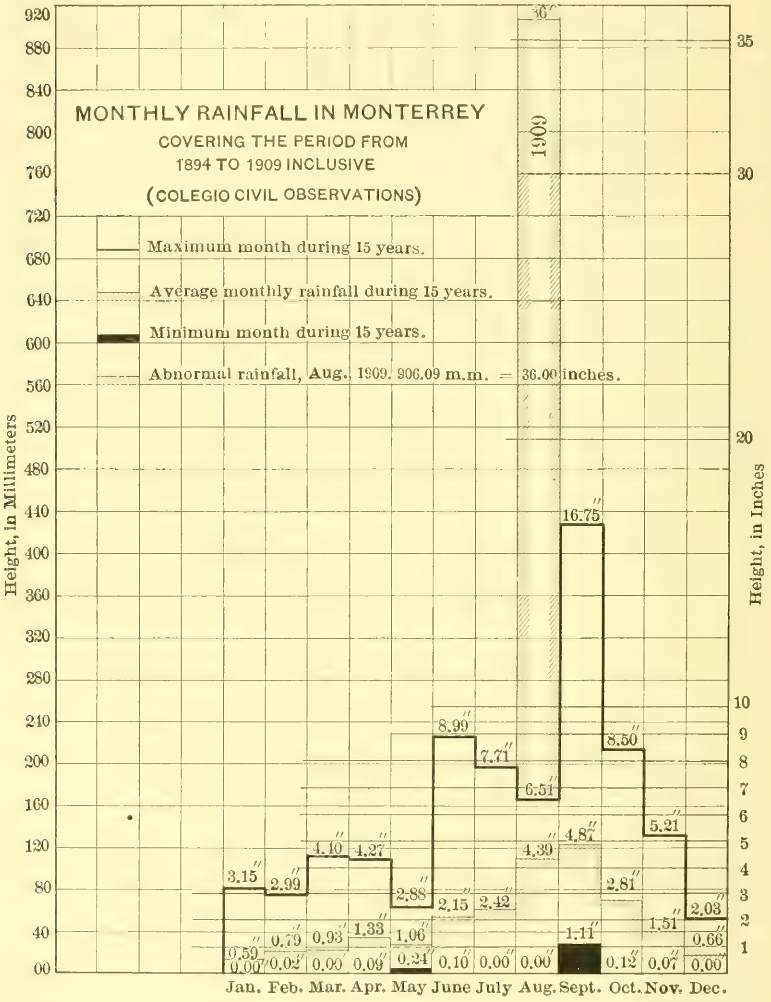


Fig. 2.

The total precipitation during the month amounted to 36.00 in. The highest previous record for the month of August was in 1895, with a fall of 6.61 in. Fig. 4 gives the details of the two heavy precipitations in August. As no automatic recording gauge was available,

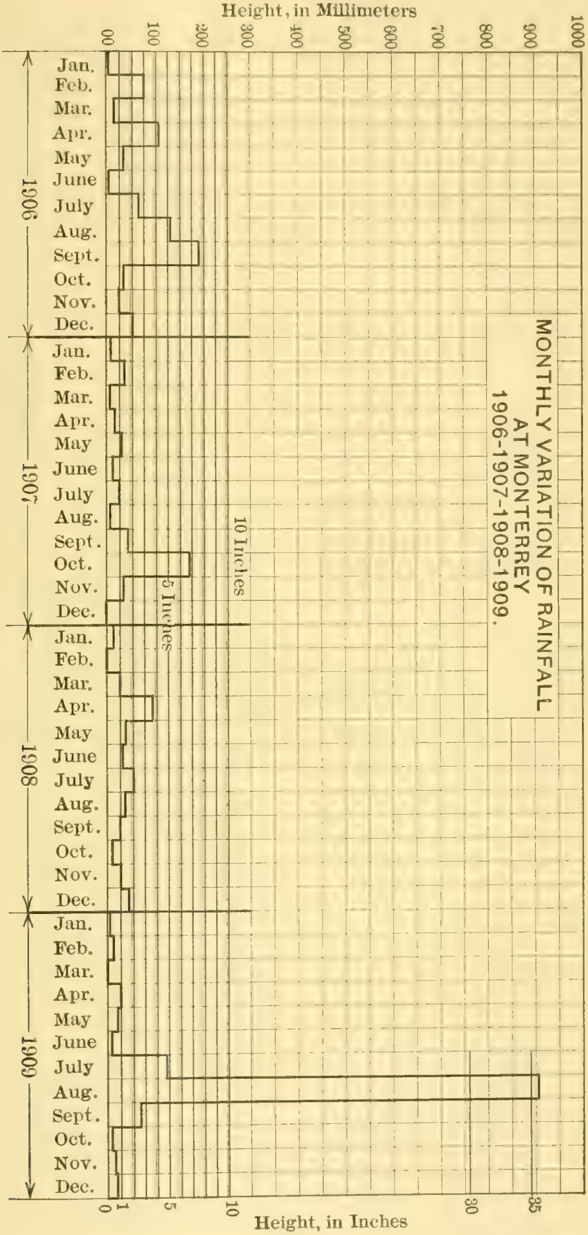

MONTHLY VARIATION OF RAINFALL AT MONTERREY 1906-1907-1908-1909.

Fig. 3.

the maximum intensity could only be computed approximately, owing to the intermittent character of the readings taken from the ordinary rain gauge on the roof of the Water-Works Company's office in the city. From the readings thus obtained, it was shown that the maximum intensity occurred early on the morning of the 28th, and was nearly 2 in. per hour. Above Monterrey, in the Santa Catarina watershed, it is believed that the precipitation was considerably greater, but no gauges were accessible during the month.

The total rainfall for 1909 amounted to 47.46 in., of which 75% fell in August. This is 50% greater than the previous highest annual record (31.65 in. in 1900) for Monterrey.

Temperature.—Fig. 6 gives a record of the temperature at Monterrey from 1901 to 1909, inclusive. These records were taken at an altitude of 520 m. It will be noted that the lowest recorded temperatures are in January and February. The lowest during these years was 24° Fahr., in January, 1905. The monthly maxima vary between 80 and 110° Fahr. The mean annual temperature is 72.65° Fahr. (The mean annual barometer is 28.2 in.)

Available Sources of Supply.

The question of the best sources from which Monterrey should be supplied with potable water was one that had been long under discussion, and was the subject of many investigations prior to the granting of the present concession. Several of the original schemes called for an impounding reservoir in the Cañon of Santa Catarina, and it was on the assumption that a dam would be built that a clause was inserted in the concession for the purpose of making its construction obligatory. The general character of the physical and geological conditions surrounding Monterrey has already been referred to. A thorough study of these conditions proved that no suitable site for impounding the Santa Catarina River could be found, apart from the fact that periodically this river is subject to enormous floods which tear through the steep cañon with tremendous velocity.

At the site originally proposed for the dam, a considerable underflow was found, and later investigations, carried out under the present concession, proved that, although borings were carried to a depth of 54 m., bed-rock could not be found, the strata being composed of gravels, conglomerate and sand. Assuming that such a dam could

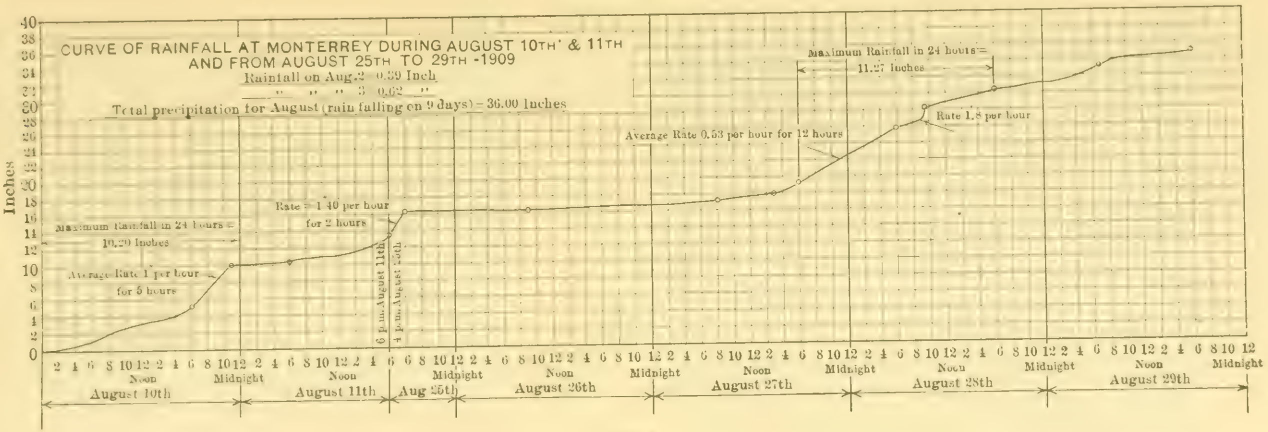
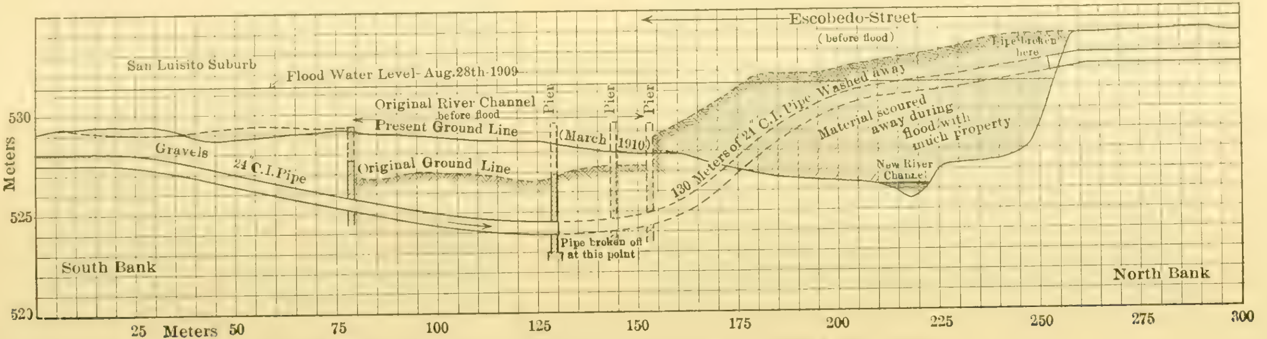


FIG. 4.


Meters
South Bank
North Bank
San Luisito Suburb
Flood Water Level- Aug.28th-1909
Escobedo-Street (before flood)
Original River Channel before flood
Present Ground Line (March 1910)
Original Ground Line
Gravels
24" C.I. Pipe
Pier
Pier
Pier
Pipe broken off at this point
130 Meters of 24" C.I. Pipe Washed away
Material scoured away during flood with much property
New River Channel
Pipe broken here

PROFILE SKETCH, LOOKING UP STREAM ON LINE OF 24-INCH MAIN SUPPLY PIPE

FIG. 5.

have been built, the quality of the water draining from a comparatively barren water-shed, on which many thousands of goats are pastured, would have made its filteration an absolute necessity before it could be delivered to the consumers.

The various available sources from which water could be delivered to the city by gravity were investigated by Mr. F. S. Hyde, in the autumn of 1905, and also by J. D. Schuyler, M. Am. Soc. C. E., who was afterward retained as Consulting Engineer for the Company. The various investigations made from time to time showed that the question of a satisfactory supply was one of extreme difficulty, requiring prolonged observation and study, more particularly into the character of the underground sources of supply.

One of the chief characteristics of many of the streams in the State of Nuevo León, is their disappearance and reappearance at different points along their routes, and the Santa Catarina River, under normal conditions, as already remarked, is a very notable example of a river which is very dry at the surface for many kilometers of its length. In the writer's opinion, the waters of this and similar rivers in the State pass through many open caverns underground, so that experience gained in the investigation of underflow waters in other places would be insufficient to determine the quantity passing at any point along the river if ascertained by merely computing it from the velocity of the underflow and the area of the water-bearing gravels. The rainfall on the water-shed of the Santa Catarina River is probably 25% greater than at Monterrey, and all ordinary rains sink rapidly into the limestone soils and quickly disappear. In another water-shed of a very similar character, namely, that of the Rio Blanco, in the southern part of the State, the underflow waters appear at the surface at a place called Mezquital, where a metamorphosed sandstone barrier prevents them from disappearing underground. At this point the normal quantity of water is about 5 660 liters (200 cu. ft.) per sec., but it gradually disappears, and a few kilometers below it has sunk to an insignificant stream, finally disappearing altogether for about 20 km. In the neighborhood of Monterrey similar conditions exist with regard to the surface-water supplies, and investigations, therefore, were directed toward obtaining unpolluted supplies from springs and underground sources.

Santa Catarina Sources.—The chief points from which it was

PLATE CLXXXIII.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.

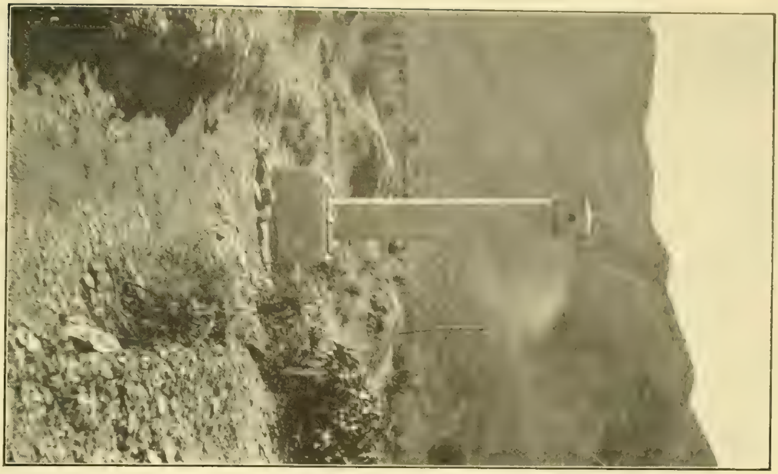


Fig. 1.—Ventilating Column and Entrance Manhole, Estanzuela Aqueduct.

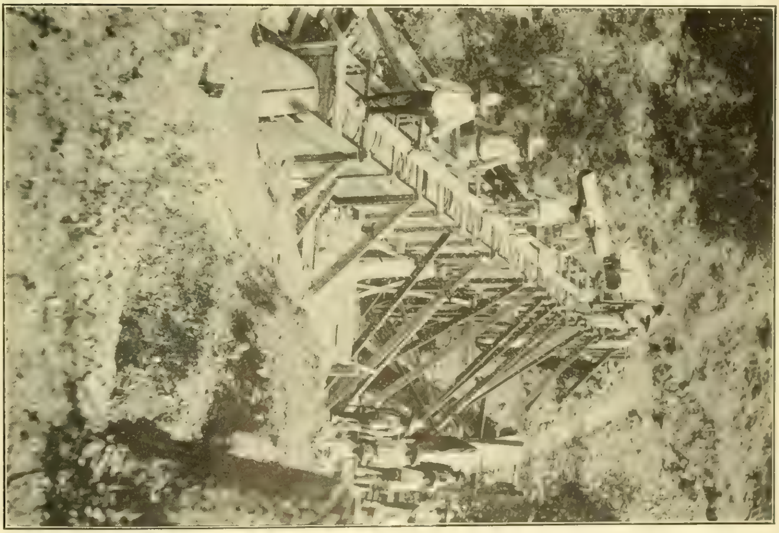


Fig. 2.—Placing Concrete Pipes in Forms for Bridge Crossing at North End of Tunnel, Estanzuela Aqueduct.

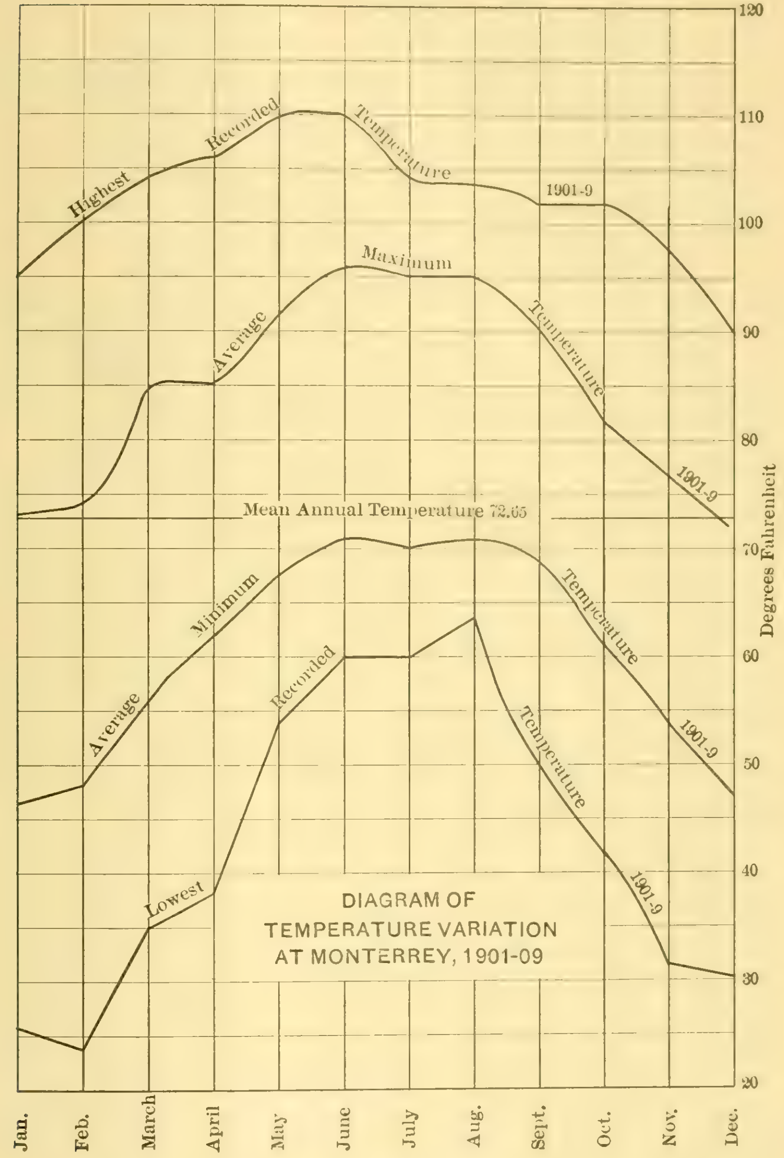

Highest Recorded Temperature 1901-9
Average Maximum Temperature 1901-9
Mean Annual Temperature 72.65
Average Minimum Temperature 1901-9
Lowest Recorded Temperature 1901-9
DIAGRAM OF
TEMPERATURE VARIATION
AT MONTERREY, 1901-09
120
110
100
90
80
70
60
50
40
30
20
Degrees Fahrenheit
Jan.
Feb.
March
April
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.

Fig. 6.

thought desirable to obtain underflow supplies were (1) at the barrier of San Geronimo, and (2) at the Cañon of Santa Catarina, both shown on Plate CLXXX.

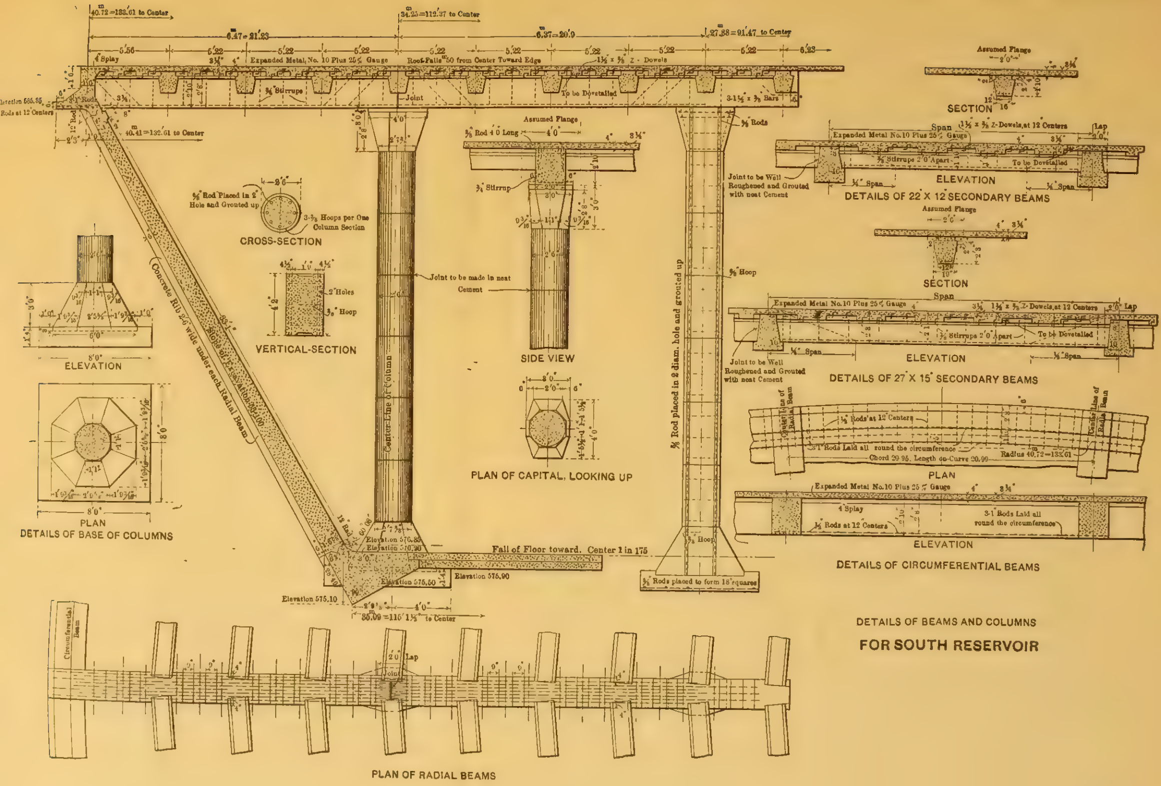
Conditions at San Geronimo, which is only 6½ km. west of Monterrey, were investigated by the State Government in 1892, to determine the depth of bed-rock, the rock on either side of the valley being shale, with its original bedding planes standing almost vertical. To determine this depth, borings were made by driving 2-in. tubes until it was assumed that bed-rock had been reached, a method which, in strata containing so many boulders, was obviously unreliable. These borings indicated that bed-rock was from 12 to 15 m. below the surface. If these had proved to be correct, there is no doubt that a development of the underground water at this point, by constructing a submerged dam combined with an infiltration gallery, would have yielded a large supply.

In March, 1906, the Company commenced operations at San Geronimo by sinking a well a few meters north of the then dry bed of the river. Water was found in considerable quantities a few meters below the surface, practically at the level of the river, that is, 570 m. above datum. This supply was used for provisional purposes, and will be referred to later in describing the San Geronimo gravity supply works.

Between August, 1906, and January, 1907, 4-in. bore-holes were sunk in the river bed and on the high ground to the north with a "Keystone" driller outfit. These borings showed bed-rock immediately under the river bed, at a depth of from 15 to 45 m., but dipping gradually as the borings were carried northward.

Boring operations were also carried on at Santa Catarina, during November and December, 1906, and in January, 1907, to determine the geological conditions, and the results are shown on Fig. 7. From the area of water-bearing gravels found, it was proposed to tap the underflow water at the 630-m. level by an infiltration gallery. This would have necessitated a gravitation tunnel 3 000 m. long, and an aqueduct of 14 km., which it was proposed to carry to one of two distributing reservoirs at Guadalupe, on the south side of the river, opposite Monterrey. In May, 1907, the writer, after making a study of all the available data which had been accumulated, had additional borings sunk farther across the valley to the north, and these revealed a considerable area of water-bearing gravels, and proved that, in former

PLATE CLXXXIV.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.


40.72 = 133.61 to Center
34.25 = 112.37 to Center
6.47 = 21.23
6.37 = 20.9
27.88 = 91.47 to Center
4 Splay
Expanded Metal No. 10 Plus 25% Gauge
Roof Falls 50 from Center Toward Edge
1½ x ⅜ Z - Dowels
⅜ Stirrups
Joint
To be Dovetailed
3-1¼ x ⅜ Bars
⅝ Rods
Rods at 12 Centers
40.41 = 132.61 to Center
⅝ Rod Placed in 2 Hole and Grouted up
3-⅜ Hoops per One Column Section
CROSS-SECTION
2 Holes
⅜ Hoop
VERTICAL-SECTION
Joint to be made in neat Cement
Center-Line of Column
Assumed Flange
⅝ Rod 4 0 Long
¾ Stirrup
SIDE VIEW
PLAN OF CAPITAL, LOOKING UP
⅝ Rod placed in 2 diam. hole and grouted up
⅜ Hoop
Concrete Rib 2-0 wide under each Radial Beam
Slope of Excavation 60:100
ELEVATION
PLAN
DETAILS OF BASE OF COLUMNS
Elevation 576.85
Elevation 576.90
Elevation 575.50
Elevation 575.10
Fall of Floor toward Center 1 in 175
35.09 = 115' 1½" to Center
⅝ Rods placed to form 18 squares
SECTION
Span
1½ x ⅜ Z-Dowels at 12 Centers
Lap
⅜ Stirrups 2' 0 Apart
Joint to be Well Roughened and Grouted with neat Cement
¼ Span
DETAILS OF 22 X 12 SECONDARY BEAMS
DETAILS OF 27 X 15 SECONDARY BEAMS
½ Rods at 12 Centers
3-1 Rods Laid all round the circumference
Chord 20.95. Length on Curve 20.99
Radius 40.72 = 133.61
Center Line of Radial Beam
DETAILS OF CIRCUMFERENTIAL BEAMS
Circumferential Beam
Lap
Joint
PLAN OF RADIAL BEAMS

DETAILS OF BEAMS AND COLUMNS

FOR SOUTH RESERVOIR

geological times, the Santa Catarina flowed about 500 m. north of its present position, and to the back of Obispado Mountain, instead of through the city. This aspect of the subject was discussed with Mr. Schuyler, who agreed with the writer that, in the interest of economy, it was better to tap this supply by an infiltration gallery at the 560-m. level, and bring the water thus obtained to a reservoir to be placed at the western limits of the city, dividing the city, for distribution purposes, into two interchangeable systems, a high- and a low-pressure, the high-pressure system being supplied from Estanzuela, 18 km. south of the city. One advantage to be gained from this change was that the scheme was capable of considerable extension, and any future developments at Santa Catarina Cañon would form part of the works to be constructed for both high- and low-pressure districts.

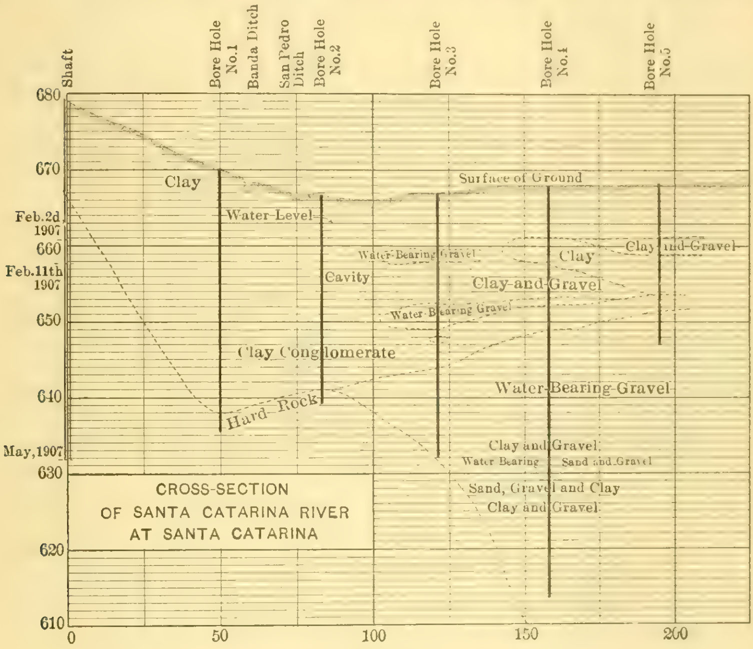


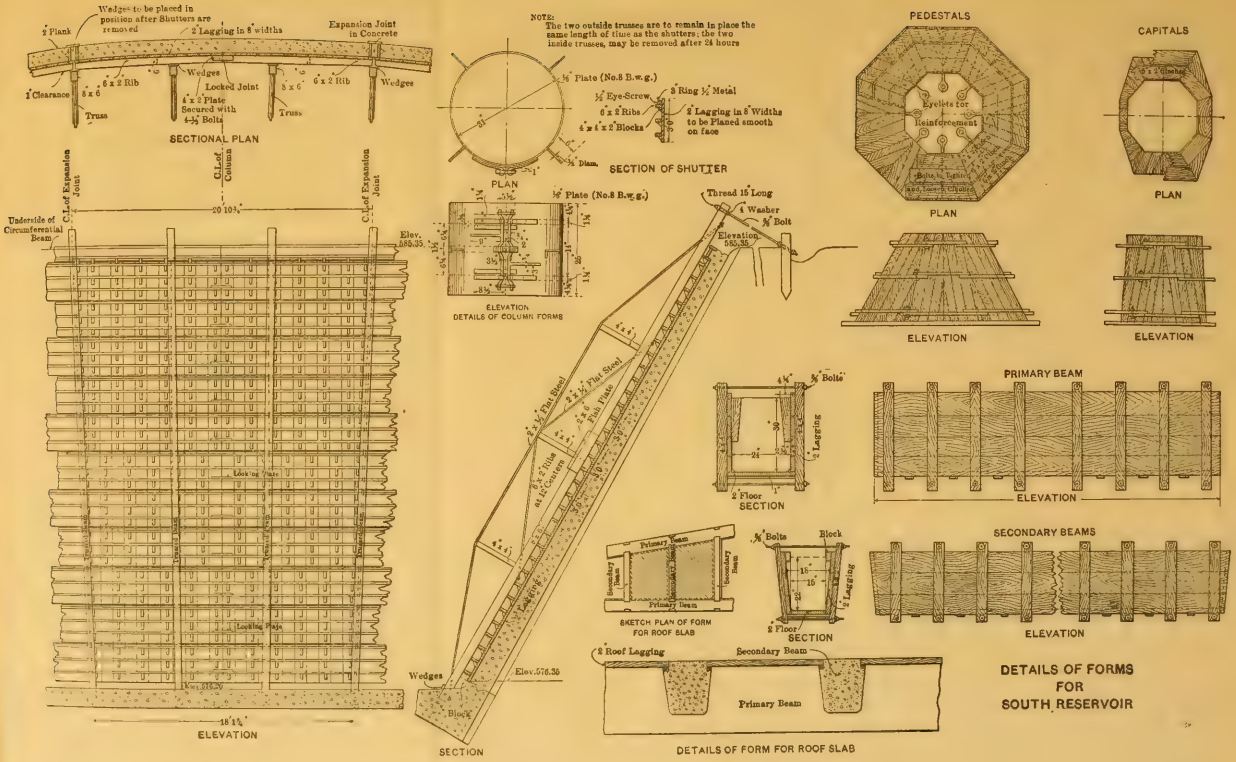
FIG. 7.

The future extension of the Santa Catarina sources, the writer believes, can be developed best by driving an infiltration gallery 10 m. below the surface of the Santa Catarina River, a little west of the village of the same name, and then conveying the water through a comparatively short gravitation tunnel and pressure conduit to a main reservoir near San Geronimo having a top water level at an elevation of about 690 m. above datum.

Southern Sources of Supply.—The available sources of supply southward from Monterrey include a number of springs at various points in a distance of 40 km. Many of these springs are of uncertain quantity, and some are quite dry during periods of drought. The chief perennial springs near Monterrey are those which contribute to form the Estanzuela and Diente Rivers, both tributaries of the Silla, while farther south, at the Potrero Cerna, near El Porvenir, there are excellent springs, at a considerable elevation, with a minimum flow of from 170 to 200 liters (from 6 to 7 cu. ft.) per sec. The total quantity of water available from all these springs during the driest season would probably not be less than about 560 or 700 liters (from 20 to 25 cu. ft.) per sec.

The Estanzuela springs issue at the foot of the Sierra Madre Mountains, and have a normal flow of from 56 to 85 liters (2 to 3 cu. ft.) per sec. in an ordinary dry year; they probably derive their water, through the limestone formation, from the neighboring water-shed of Santa Catarina, as the catchment area of the stream is only 910 hectares, and the stream has never been known to fail, even in the driest periods of prolonged drought. The rainfall on the area is about 30 in. per annum, and the catchment area is well wooded and covered with abundant vegetation. The El Diente springs have an ordinary dry-weather flow of about 28½ liters (1 cu. ft.) per sec.; but part of the water is carried underground, and the real quantity is much greater and could be developed by a small submerged dam carried down to bed-rock.

The elevation and the extreme purity of the water of the Estanzuela River made its acquisition very desirable, and the Company, therefore, purchased the Federal water rights owned by various members of the Estanzuela community, amounting to 91 liters per sec., and has since acquired a Federal concession to all the flood-waters of that river. It was decided, therefore, to adopt the Estanzuela River as the first step toward developing the water to the south of Monterrey for a high-pressure supply, the advantage of the scheme being that from time to time extensions could be made to tap other sources by gravity, as the demands of the city required. The Estanzuela scheme, there-



DETAILS OF FORMS
FOR
SOUTH RESERVOIR

fore, is a preliminary step toward future extensions which will be necessary in this direction as the city grows. The springs near El Porvenir, and others which contribute to the San Juan River, can be tapped at a sufficiently high level to convey them by a gravity pressure line to the Estanzuela Aqueduct near Mederos.

The two sources definitely decided on in July, 1907, were those from the Estanzuela and San Geronimo Rivers. The works were designed to supply 40 000 000 liters daily, which it was assumed would be sufficient for all future developments for a population of 200 000 at a per capita consumption of 200 liters per day. The present requirements of the city's population, assuming that all the water was supplied by the Company, would be, at that rate, which is a very liberal one, only 18 000 000 liters daily. This, it was thought, would be easily met by the San Geronimo source alone, as it was estimated that it would provide not less than 20 000 000 liters, if the infiltration gallery was driven far enough into the water-bearing gravels.

The question of a high-pressure water supply for domestic use in a city like Monterrey is not a serious one, as practically nine-tenths of the houses are of one story. The increase in the number of large commercial buildings, however, will make the demand greater in the future, and this point has been kept in mind in arranging the division of the distribution systems.

MATERIALS FOR CONCRETE.

Cement.—In the early stages of construction the cement for the work was obtained from the Associated Portland Cement Manufacturers, Limited, of London, which supplied the "Pyramid" brand, from the Knight, Bevan, and Sturges Works, but later the supply was obtained from a new factory at Hidalgo, near Monterrey. The total quantity of Portland cement used was 42 500 bbl. of "Pyramid" and 32 500 bbl. of "Hidalgo." The English cement was tested for the Water-Works Company in London before shipment and again at Monterrey, to conform to the British Standard Specifications; the "Hidalgo" cement was required to pass the Standard Specifications advocated by the Special Committee of the American Society of Civil Engineers. The quality in each case was of the very highest, no difficulties being experienced at any time.

Sand and Rock.—One of the chief difficulties in connection with the construction work in its initial stages was in procuring satisfactory sand for the concrete. An investigation of the quality of all the available sands in the neighborhood of Monterrey resulted in the decision to use a manufactured sand obtained from the calcareous shales in the foot-hills opposite the city, on the south side, and near the site of one of the proposed reservoirs. A quarry was opened, and the raw material was delivered by a gravity plane to a crushing plant, 230 m. from the quarry and at a level about 50 m. lower.

The plant consisted of a No. 5 Austin gyratory rock-crusher, fitted with elevators and revolving screens of various dimensions, driven by a 150-h.p. Erie steam engine; two sets of Traylor's heavy-duty crushing rolls, one having 30 by 16-in. and the other 18 by 12-in. rolls; and a Niagara sand disintegrator. This plant, except during a short period when the requirements were beyond its capacity, was able to produce all the sand and rock required for construction purposes. More than 40 000 tons of rock were quarried, the greater part of which was converted into crushed stone and sand.

Table 2 gives the chemical analysis of the chief constituents of the various sands examined.

TABLE 2.—ANALYSIS OF SANDS IN THE NEIGHBORHOOD OF MONTERREY.

No.	Location.	Percentage of silica (absolute), $Si O_2$	Percentage of alumina, $Al_2 O_3$	Percentage of sesqui-oxide, $Fe_2 O_3$	Percentage of lime carbonate, $Ca CO_3$
1..	Arroyo Seco, near brickyard at Monterrey	60.10	17.95	2.89	8.01
2..	Arroyo Seco, near brickyard at Monterrey, No. 2	42.92	14.26	4.66	34.58
3..	Near García Station, Mexican National R. R., Chiquito River, No. 1	50.22	9.72	1.44	34.62
4..	Near García Station, Mexican National R. R., Chiquito River, No. 2	48.7	4.92	8.28	35.43
5..	San Luis Potosí	85.02	5.00	7.38	2.21
6..	Topo Grande, Pesquería River	40.20	5.15	4.25	46.50
7..	Hornos, near Torreón	77.9	13.1	2.4	4.9
8..	Salinas River, at Salinas	41.5	5.7	1.4	48.2
9..	Pits near Caballeros, on Tampico Branch of Mexican Central R. R.	73.4	5.6	4.4	10.1
10..	Santa Catarina River, near San Geronimo (washed sand)	12.40	2.06	1.14	81.70
11..	Santa Catarina River, at Monterrey	17.4	2.50	2.00	77.00
12..	Composition of rock, quarry in foot-hills opposite Monterrey, Monterrey Water-Works and Sewerage Company's property	40.44	15.70	2.20	34.30
13..	Manufactured sand from above quarry (run of crusher)	51.80	12.14	3.7	32.6

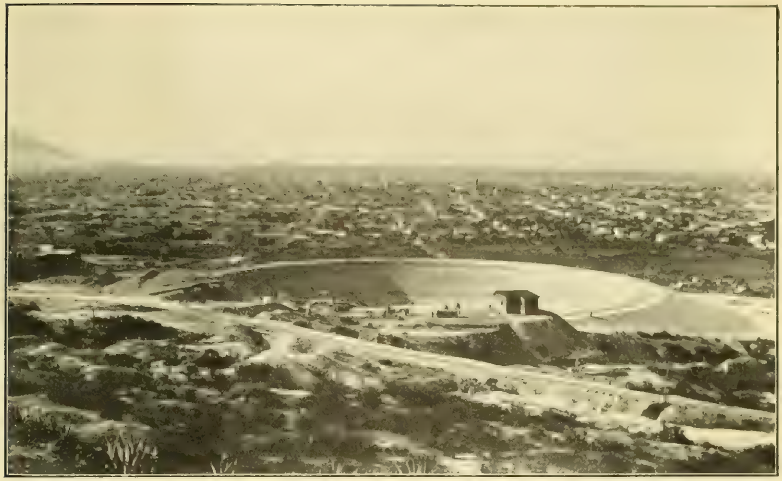


FIG. 1.—GENERAL VIEW OF EXCAVATION AND EMBANKMENT FOR SOUTH RESERVOIR BEFORE LINING.

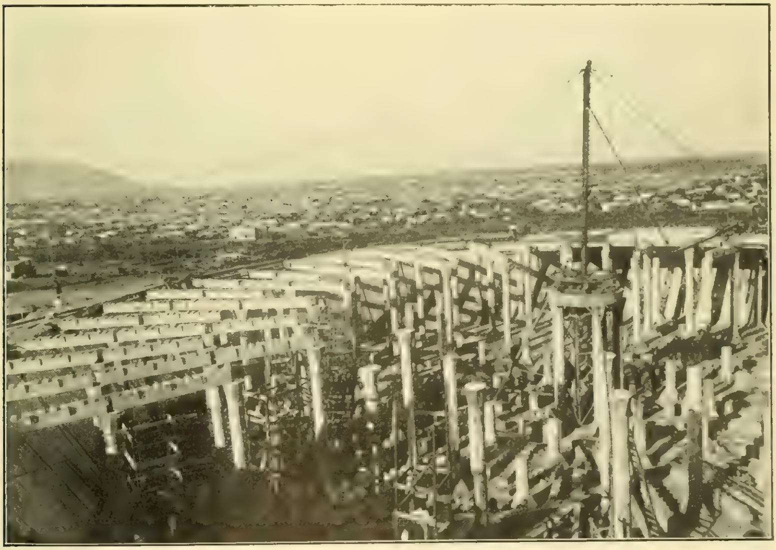


FIG. 2.—VIEW OF WESTERN HALF OF SOUTH RESERVOIR, SHOWING FINAL SETTING UP OF DERRICK ON CENTRAL COLUMNS.

The chief sands used for ordinary building purposes in Monterrey are Nos. 10 and 11, which are procured from the bed of the Santa Catarina River. As these sands contain large proportions of lime carbonates, which make them very undesirable for important structures, their use was limited to relatively unimportant work. The best sands procurable were Nos. 5 and 9, but the long distance of the pits from Monterrey, and consequently the heavy freight rate, made their use prohibitive on economical grounds. The best of the available sands, although it was very fine, was No. 7, from Hornos, near Torreon, as it could be depended on for uniformity and could be obtained f. o. b. cars at Monterrey for 3.18* pesos per ton.

The bulk of the sand and crushed rock used was similar to Nos. 12 and 13, and reference to the cement sand tests in Table 3, will show that the manufactured sands gave very satisfactory results.

Table 3 gives the average tests made with the "Hidalgo" cement and various sands, alone and in combination, for the purpose of obtaining comparative results; the mixtures tested were composed of 3 parts of sand to 1 of cement.

TABLE 3.—TESTS OF "HIDALGO" CEMENT WITH VARIOUS SANDS.

Sand.	At 7 days.	At 28 days.
Ottawa (Standard)	305 lb.	414 lb.
Monterrey, 1½ parts, Hornos, 1½ parts	188 "	313 "
Monterrey	253 "	365 "
Hornos	202 "	301 "
Manufactured sand, Company's crusher	372 "	566 "
Hornos, 2 parts, Crusher sand, 1 part	231 "	352 "
Hornos, 1½ parts, Crusher sand, 1½ parts	265 "	346 "
Hornos, 1 part, Crusher sand, 2 parts	248 "	328 "

The Hornos sand was used during a few weeks in the latter part of 1908, when the crusher was unable to produce all that was required. Its use was restricted to thick walls which were required to be watertight, and it was always used in equal proportions with the crusher dust.

---

* All costs given in this paper are in Mexican pesos, one peso being equivalent to 50 cents in U. S. currency.

Estanzuela Supply.

Intake Works.—The intake (Fig. 8) is about 1 km. below the lowest spring and at a point where the maximum flow of the stream was observed. The works consist of a small monolithic concrete dam, placed obliquely across the stream at an angle selected for the purpose of obtaining a foundation running parallel to the direction of the strata, which at this point were lying almost vertically across the bed of the stream. Above these strata the stream bed was formed chiefly of large cemented limestone blocks and smaller conglomerate. No storage being possible in this valley, which has a very precipitous fall, the height of the dam was fixed merely to obtain a small settling basin for sand and débris brought down in time of flood. The dam foundation was excavated to bed-rock, from which the upper disintegrated portions were carefully removed; the rock was then stepped, and dovetailed recesses were left for properly bonding the concrete.

The dam is carried well into the banks. Its extreme length is 52 m., its maximum height 4.50 m., and its greatest thickness 2 m. The up-stream face has a batter of 1 in 12, and the down-stream face, 1 in 8. The top of the wall is 1 m. thick. For the discharge of flood-water there is a weir 10 m. long, and it was calculated that with a depth of 1 m. it would discharge about 400 times the ordinary flow, or about 23 000 liters per sec., but, in addition, the whole length of the dam (excluding that occupied by the gate-house) was arranged for the discharge of abnormal floods, one of which, on August 27th, reached the enormous quantity of 82 070 liters (2 900 cu. ft.) per sec., or 825 cu. ft. per sec. per sq. mile of drainage area, a remarkable run-off from so small an area as 910 hectares. The concrete forming the dam is a 1 : 3 : 5 mixture. The overflow sill is 692 m. above sea level. When the dam was completed it was filled to the overflow level, in order to test the water-tightness of the basin, which, when cleared, was found to be slightly fissured on the north side. The leakage was sufficient to cause a serious loss during periods of drought, and it was then decided to line the basin with concrete, so that the stream would enter it without being under a head greater than its own depth. The length of the basin, measured along the center line of the original stream surface, is 85 m., and its area is 1 100 sq. m. At its upper end it is merely a lined channel, 5 m. wide at the entrance. The floor of the basin has a fall of 4 m. The lining was formed in

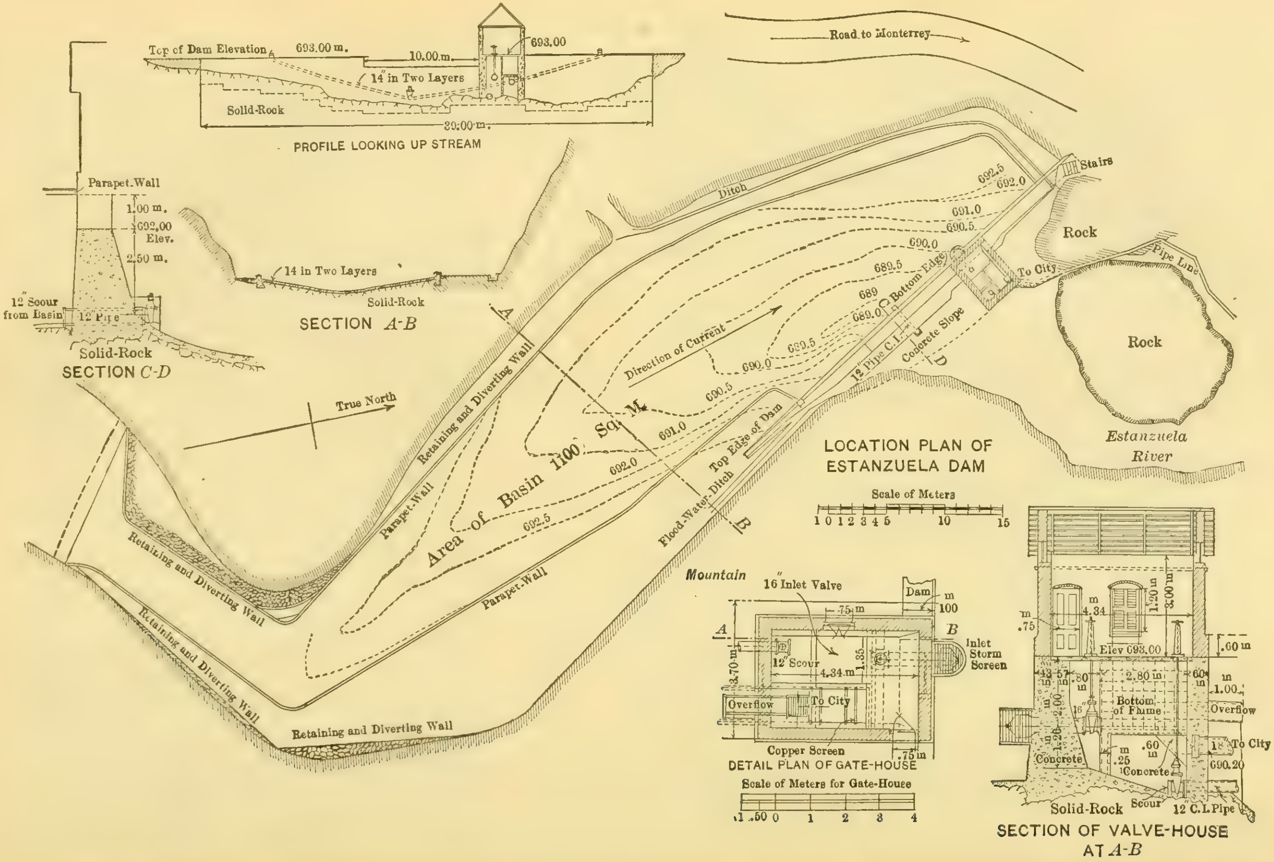

PROFILE LOOKING UP STREAM
Top of Dam Elevation
693.00 m.
10.00 m.
14" in Two Layers
Solid-Rock
20.00 m.
693.00
Road to Monterrey
SECTION C-D
Parapet Wall
1.00 m.
692.00 Elev.
2.50 m.
12" Scour from Basin
12" Pipe
Solid-Rock
SECTION A-B
14 in Two Layers
Solid-Rock
True North
LOCATION PLAN OF ESTANZUELA DAM
Retaining and Diverting Wall
Parapet Wall
Area of Basin 1100 Sq. M.
Direction of Current
Ditch
Stairs
Rock
To City
Pipe Line
Rock
Estanzuela River
Bottom Edge
12" Pipe C.I.
Concrete Slope
Top Edge of Dam
Flood-Water Ditch
692.5
692.0
691.0
690.5
690.0
689.5
689
689.0
A
B
C
D
Scale of Meters
1 0 1 2 3 4 5 10 15
Mountain
DETAIL PLAN OF GATE-HOUSE
16" Inlet Valve
Dam
.100 m
.75 m
3.70 m
12" Scour
4.34 m
1.35
Overflow
To City
Inlet Storm Screen
Copper Screen
.75 m
Scale of Meters for Gate-House
.1 .50 0 1 2 3 4
SECTION OF VALVE-HOUSE AT A-B
.75 m
4.34 m
1.20 m
3.00 m
Elev 693.00
.60 m
.43 m
.57 m
.80 m
2.80 m
.60 m
1.00 m
2.00
1.20
16"
Bottom of Flume
Overflow
18" To City
690.20
.25 m
.60 m
Concrete
Concrete
Solid-Rock
Scour
12" C.I. Pipe

Fig. 8

two thicknesses totaling 30.5 cm. (12 in.) of 1 : 2½ : 3½ concrete, laid in panels approximately 3 m. square, the upper panels breaking joint with those immediately below; in this way a very satisfactory and water-tight lining was obtained. A parapet wall, 45.7 cm. high, surrounds the basin. For scouring out the basin a 30.5-cm. (12-in.) cast-iron pipe was taken through the dam at the lowest point, this pipe being provided with a gate-valve encased in concrete on the downstream face.

The gate-house was built in connection with the dam at the north end of the overflow weir, its inner dimensions being 4.34 by 2.80 m. The substructure, to the level of the dam, is of concrete founded on the solid rock, and the superstructure is of brick rendered with cement plaster. The roof is of framed timber with red French tiles.

The intake pipe is of cast iron, 40.6 cm. (16 in.) in internal diameter, fitted outside with a movable copper screen which is further protected by a wrought-iron hinged screen to prevent damage from stones, floating timber, etc., during times of flood. Inside the gate-house the outlet pipe is provided with a 40.6-cm. (16-in.) sluice-valve, operated from the floor level by a vertical head-stock with worm-gearing. The gate-house has a scour-out pipe (also operated by a head-stock) and duplicate copper screens fitted to iron frames. From this house the water is conveyed to the upper portion of the conduit, which is a 45.7-cm. (18-in.) cast-iron pipe.

Of the total area of land, 885 hectares (2 187 acres), owned by the company, 392 hectares (970 acres) have been fenced in, to prevent any contamination of the springs. This fence is formed of five lines of barbed wire protected with stout hog netting at the bottom, in order to prevent more particularly the entrance of goats, many thousands of which pasture in the adjoining mountains.

On the high ground immediately below the intake, a 3-roomed stone house has been constructed for the inspector in charge of the intake works, who also keeps in daily touch with the general office and records the condition of the stream, particulars of rainfall, etc.

Aqueduct.—The total length of the aqueduct, from the intake dam to the South Reservoir, is 18 700 m., made up as shown in Table 4.

The gradient of the concrete pipes is 0.43% from Estanzuela to Mederos, and 0.53% from Mederos to the South Reservoir. The calculated discharging capacity of the conduit when running full is 364

PLATE CLXXXVII.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.

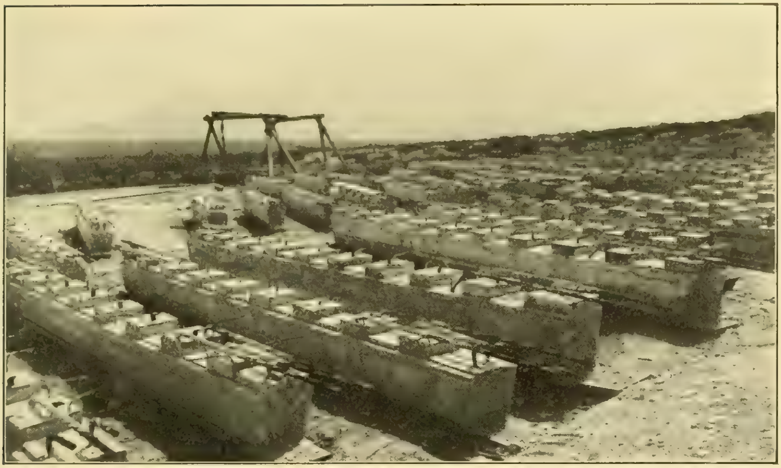


FIG. 1.—VIEW OF SEPARATELY MOULDED SECONDARY BEAMS IN YARD BELOW SOUTH RESERVOIR.

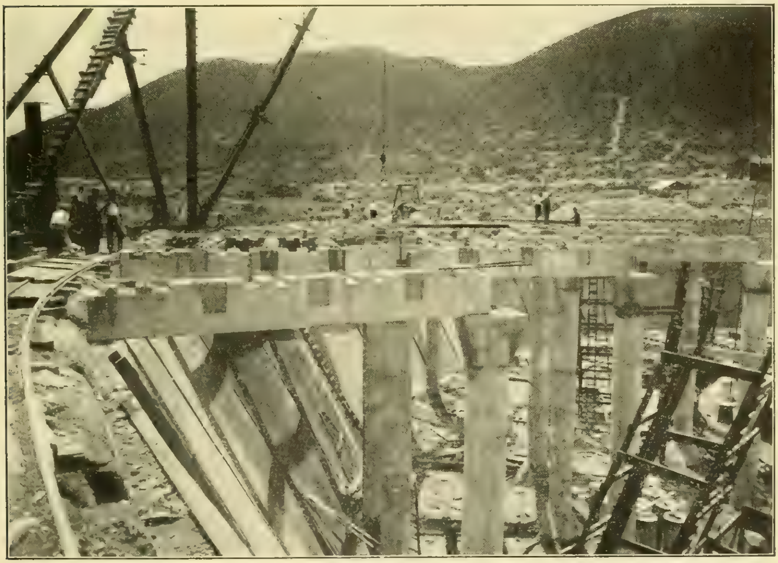


FIG. 2.—SETTING PRIMARY BEAMS, SOUTH RESERVOIR.

liters (13 cu. ft.) per sec. for the upper, and 465 liters (16.4 cu. ft.) per sec. for the lower section. For these pipes, the coefficient, *n*, in Kutter's formula, was taken at 0.013. At present the line has been limited by overflows to discharge three-quarters full.

TABLE 4.—ESTANZUELA AQUEDUCT.

Description.	Length, in meters.
Cast-iron pipes, 45.7 cm. (18 in.) in diameter, along the stream bed of the Estanzuela River	110
Concrete tubes, 55.9 cm. (22 in.) in diameter, to Mederos (including 281 m of tunnel)	4 473.81
Cast-iron siphons, 45.7 cm. (18 in.) in diameter: Calabozos.....239 m. South Virgen.124 " North Virgen.177 " Mederos......426 "	966
Concrete tubes, 63.5 cm. (25 in.) in diameter, Mederos to South Reservoir.	12 039.19
Cast-iron siphons, 50.8 cm. (20 in.) in diameter: Necaxa........315 m. San Agustin...796 "	1 111
Total	18 700

The increase in the size of the pipes from Mederos is for the purpose of receiving the waters of the Mederos River and other springs in the San Pablo and Aqua Verde catchment areas, as shown on Plate CLXXX.

The invert of the concrete conduit where it leaves the Estanzuela River is 684.25 m. above datum, and at the valve-house of the South Reservoir it is 589.00 m.

The concrete pipes were manufactured and laid under contract with Mr. Arthur S. Bent, of Los Angeles, Cal., the Company providing all materials, labor, etc. The contractor was paid 10 cents per lin. ft. of pipe manufactured and 10 cents per lin. ft. laid. He was also responsible for the satisfactory completion of the work.

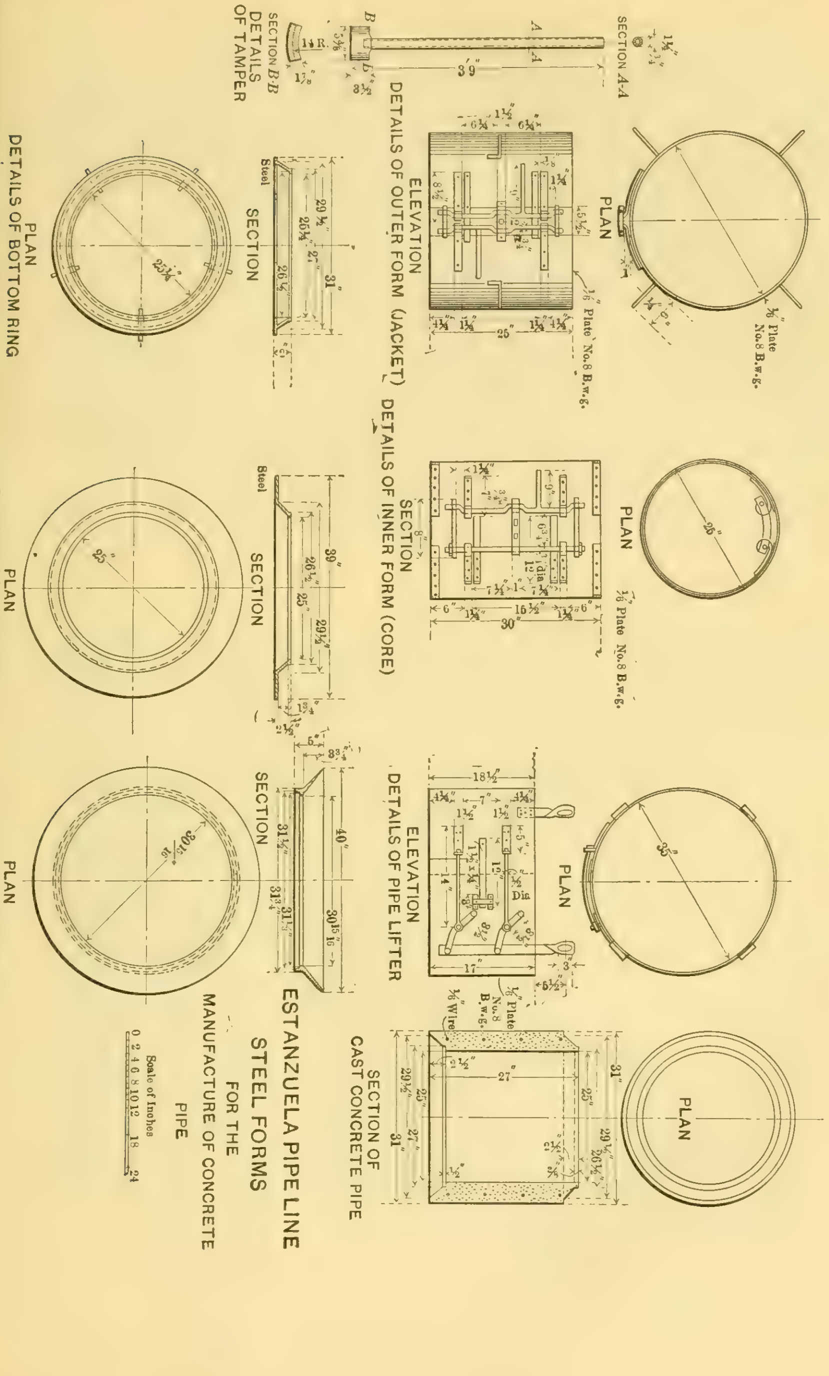
Fig. 9 shows the details of the joint recommended by Mr. Schuyler and adopted for these pipes. The 63.5-cm. (25-in.) pipes were 61 cm. long and 76 mm. (3 in.) thick. The 55.9-cm. (22-in.) pipes were of the same length, but 70 mm. (2¾ in.) thick. For the purpose of strengthening these pipes while hauling them over very rough roads they were reinforced with four rings of No. 6 galvanized-iron wire.

Manufacture of Pipes.—The pipes were manufactured under the supervision of Mr. H. Stanley Bent, at a pipe yard established below the crushing plant, from which the crushed rock and sand were delivered by gravity in bogies run on narrow-gauge rails. The area of the pipe yard was approximately 1¼ hectares, and it was laid out with parallel lines of 76-mm. (3-in.) galvanized-iron piping with hose couplings for sprinkling purposes. After trials with aggregates of various sizes, the concrete for the pipes was proportioned by volume as follows:

Crushed rock broken to pass through a 19-mm. screen..............	0.136 cu. m.
Manufactured sand (run of rolls)..	0.119 " "
Portland cement.....................	0.090 " "
Total.....................	0.345 cu. m. = (12.2 cu. ft.)

The above quantity manufactured two 63.5-cm. pipes; a 55.9-cm. pipe required 0.1415 cu. m. (5 cu. ft.) of the material, in the same proportions. Fig. 9 shows the forms for these pipes, and Fig. 2, Plate CLXXXI, illustrates the process of moulding. The forms consist of cast-iron bottom rings, to the proper section of the joint, and inner and outer steel forms of 3-mm. plate, provided with inner and outer locking arrangements. The concrete was poured through a cast-iron hopper which fitted to the top of the outer form.

The concrete, which was mixed very dry, in a ½-cu. yd. batch, "Smith" mixer, was thoroughly tamped with a 22-lb. tamper, and worked until it was of a stiff jelly-like consistency, the wire rings being added as the concrete was placed. The best results were obtained with the minimum quantity of water. The upper joint was moulded with a heavy cast-iron ring. The jacket and core forms were loosened immediately, and placed over other rings, a sufficient number of bottom rings being used for a day's work. For the pipes required for curves, special forms were used to give the necessary bevel to the joint. After 24 hours the finished pipes were lifted from the bottom ring with a special lifter, and ranged in position for coating internally with a Portland cement grout to which a little freshly slaked lime was added. The pipes were all numbered, and were kept moist for 10 days by constant sprinkling. They were not hauled to the work until 28 days after they were moulded, although this rule was sometimes broken, to the detriment of the pipes. More than 32 000 pipes were



ESTANZUELA PIPE LINE

STEEL FORMS FOR THE MANUFACTURE OF CONCRETE PIPE manufactured, but some were used for purposes other than the Estanzuela Aqueduct.

Cost of Pipes.—The contractor brought with him experienced concrete pipe makers from California, and these were afterward assisted by Mexican labor. In a day two tampers could manufacture from 45 to 50 pipes of the larger (63.5-cm.), and from 55 to 60 of the smaller (55.9-cm.) size.

The cost varied from 2.75 to 3.25 pesos per pipe for the smaller, and from 3.50 to 4.00 pesos for the larger size.

The approximate cost of manufacturing is as follows: Taking, as a fair example, one week's work during March, 1908, the wages paid to the 74 men comprising the total pay-roll (though part of this labor was intermittent) amounted to 981 pesos. This includes a general foreman at 10 pesos per day, four American tampers at 7.50 pesos, and Mexican labor varying from 4 to 1 peso, and all labor necessary to handle and finish the pipes, including coating the interiors. During this week there were made 1 126 of the 63.5-cm. and 1 095 of the 55.9-cm. size. The pay-roll includes 520 pesos for the larger pipes (46 cents each) and 461 pesos for the smaller pipe (42 cents each). Table 5 shows the quantities and cost of the materials used in the manufacture of these pipes.

From Table 5 it is seen that the cost of the 63.5-cm. pipes was 3.37 pesos for material plus 0.46 peso for labor = 3.83 pesos per pipe, or 6.26 pesos per lin. m. (1.91 pesos per lin. ft.).

TABLE 5.—COST OF CONCRETE PIPE.

Materials.	For 1 126 pipes 63.5 cm. in diameter.		For 1 095 pipes 55.9 cm. in diameter.	
	Quantities.	Cost.	Quantities.	Cost.
Portland cement, at 8.00 pesos per bbl., delivered at pipe-making yard.	401 bbl.	3 208.00 pesos.	303 bbl.	2 424.00 pesos.
Sand, at 2.65 pesos per cu. m.........	85 cu. m.	225.25 "	68 cu. m.	180.20 "
Crushed rock, 19-mm. (¾-in.), at 2.65 pesos per cu. m.....................	62 cu. m.	164.30 "	50 cu. m.	132.15 "
No. 6 galvanized-wire hoops, 4 rings to each pipe.........................	4 504	203.00 "	4 380	183.00 "
Totals............	......	3 800.55 pesos.	......	2 919.45 pesos.
Cost per pipe.....	......	3.37 pesos.	......	2.66 pesos.

PLATE CLXXXVIII.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.

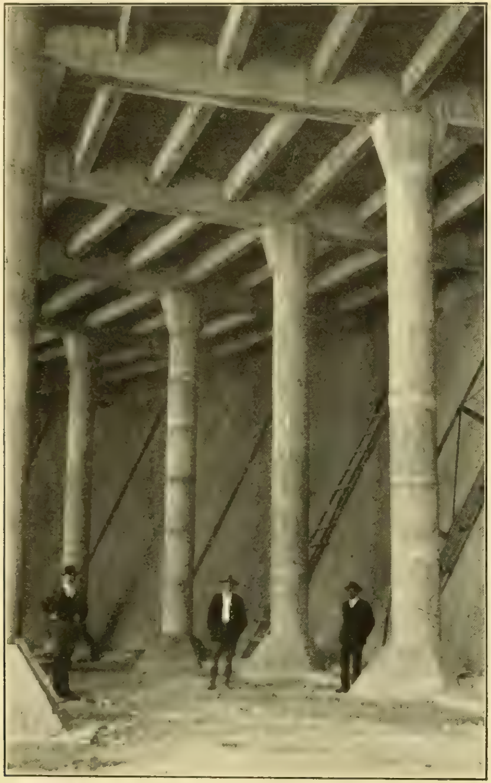


FIG. 1.—VIEW OF COMPLETED SECTION OF SOUTH RESERVOIR.

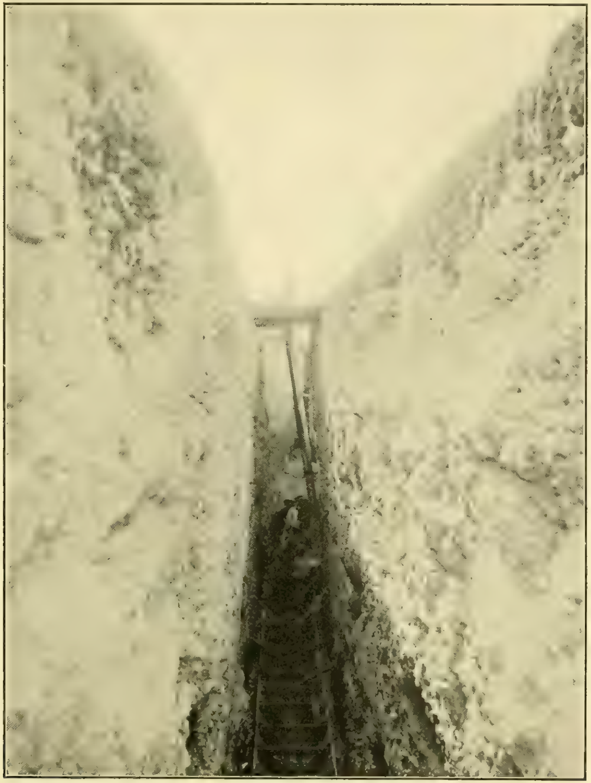


FIG. 2.—SETTING FORMS FOR SAN GERONIMO CULVERT.

The cost of the 55.9-cm. pipes amounted to 2.66 pesos for material plus 0.42 peso for labor = 3.08 pesos per pipe, or 5.05 pesos per lin. m. (1.54 pesos per lin. ft.).

The cost of cement included hauling from the bodega to the yard, a distance of about 5 km. At a later date, after the Company had commenced using the "Hidalgo" cement, some additional 55.9-cm. pipes were manufactured, so as to have them on hand as a reserve in case of emergency. In this work only Mexican labor was used, as the previous gang had been dispersed, but the tampers had had previous experience. Taking the cost of 418 pipes made during one period of 9 days, the detailed cost was as given in Table 6.

TABLE 6.—COST OF 55.9-CM. CONCRETE PIPES.

LABOR FOR 9 DAYS.		
Tampers, 2 at 4 pesos	72.00	Pesos.
Cement mixers (hand-mixing) and helpers, 6 at 1 peso	54.00	"
Water boy	4.50	"
Proportion of time of crusher foreman, one-third of 6 pesos, 2 pesos	18.00	"
Making 1 672 wire hoops, at 5 pesos per thousand	8.36	"
Man coating pipe, at 1 peso per day	5.00	"
Cost of labor making 418 pipes	161.86	Pesos.
Cost of labor per pipe	0.38	Peso.
MATERIAL.		
Cement, 118½ bbl., at 6.40 pesos per bbl., at pipe-making yard	758.40	Pesos.
Sand. 24.6 cu. m., at 2.50 pesos per cu. m	61.50	"
Rock, 21.6 cu. m., at 2.00 pesos per cu. m	43.20	"
No. 6 wire, 3 362 lin. m	55.56	"
Lime	1.50	"
Cost of material for 418 pipes	920.16	Pesos.
Cost of material per pipe	2.20	"
Add cost of labor	0.38	"
Total cost per pipe for labor and material	2.58	Pesos.
Equivalent to 4.23 pesos per lin. m., or 1.29 pesos per lin. ft.		

Excavation for Pipe Line and Siphons.—The excavation for the pipe line and for bridge works, etc., was let by contract to Messrs. Scott and Lee, of Monterrey, under three classifications:

(1) "All material which in the judgment of the Engineer can be economically loosened with picks and handled with shovels."

(2) "Indurated earth or gravel, shale or rock which can be loosened without blasting, and 'sillar,' locally so-called, whether pure or mixed with other substances, and whether it requires blasting or not."

(3) "All rock not included in the above which requires drilling or blasting."

Locally, this classification is well understood, particularly No. 2, as it covers the sillar soils which are common in the neighborhood of

Monterrey. The contract prices were: No. 1, 50 cents; No. 2, 1.50 pesos; and No. 3, 2.50 pesos per cu. m. These prices were over and above the clearing and grubbing of the line, which was paid for at the rate of 100 pesos per hectare.

The route of the pipe line being along broken country, at some points difficult of access, service roadways, about 3 m. wide, for hauling material were constructed, and, for about 7 km., a roadway was made along the line of the trench.

The prices for the roadway, under the above classification, were: For No. 1, 35 cents; No. 2, 1.50 pesos; and No. 3, 2.50 pesos per cu. m.

The trenches were excavated 5 cm. below the required finishing depth, to allow for grading the pipes in selected material, and were taken out to an average width of 40 cm. greater than the outside diameter of the pipe, to allow for their proper jointing, and also to give sufficient room to roll the pipes in the trenches.

The final quantities of excavation were:

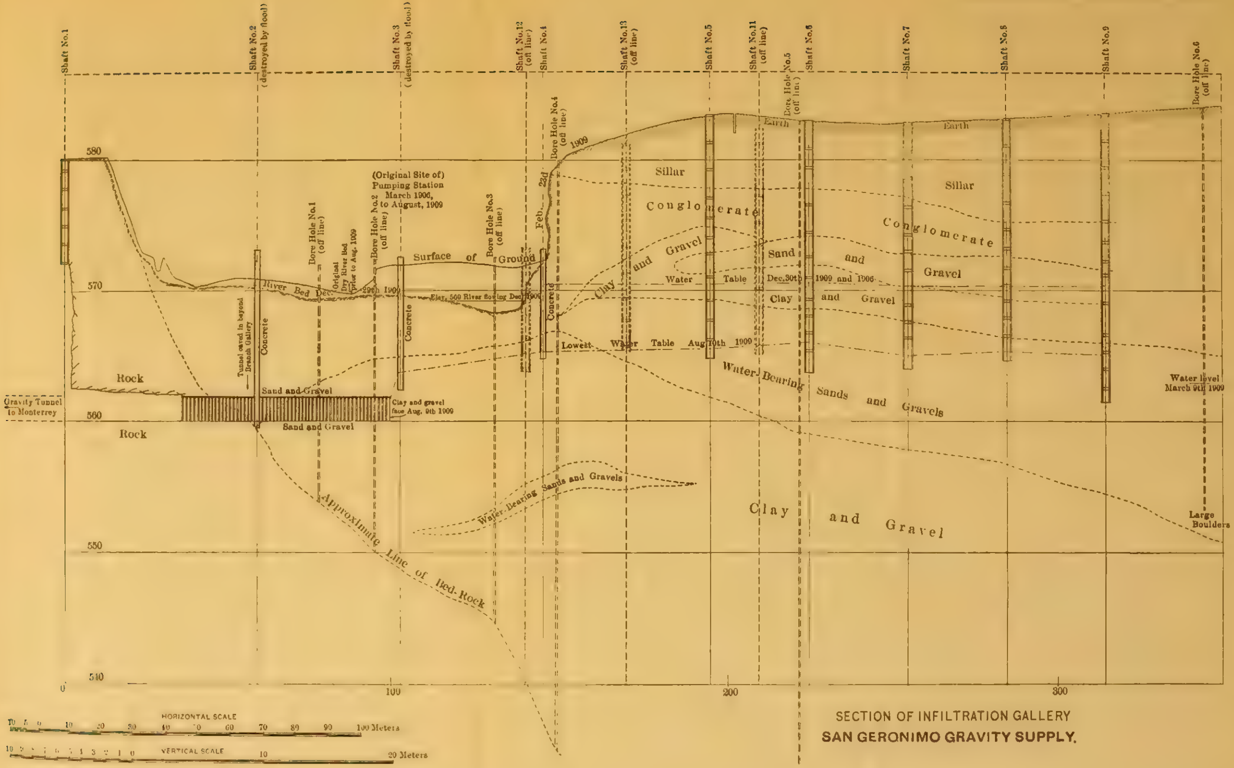
TRENCH:	No. 1	11 115 cu. m.
	No. 2	18 096 " "
	No. 3	6 650 " "
	Total	35 861 cu. m.
ROADWAYS:	No. 1	4 165 cu. m.
	No. 2	1 999 " "
	No. 3	30 " "
	Total	6 194 cu. m.

The route of the pipe line was laid out so as to obtain an average fill of not more than 1 m. over the tops of the pipes, but in some cases the cuts, for short lengths, were 3 m. deep. The excavation for this work began in June, 1907.

Hauling Pipes.—The pipes were hauled to the site of the work with ox-carts and mule teams. The cost of hauling varied from 25 cents per pipe at the lower end, to 1 peso per pipe at the upper and, comparatively speaking, inaccessible portion of the line. The weight of the 55.9-cm. pipe was about 182 kg.; that of the 63.5-cm. pipes was about 216 kg.

The breakages in all the pipes cast at the pipe yard amounted to about 1%, due chiefly to unloading them carelessly near the pipe line.

PLATE CLXXXIX.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.


Shaft No.1
Shaft No.2 (destroyed by flood)
Shaft No.3 (destroyed by flood)
Shaft No.12 (off line)
Shaft No.4
Shaft No.13 (off line)
Shaft No.5
Shaft No.11 (off line)
Bore Hole No.5 (off line)
Shaft No.6
Shaft No.7
Shaft No.8
Shaft No.9
Bore Hole No.6 (off line)
Bore Hole No.4 (off line)
580
570
560
550
540
(Original Site of) Pumping Station March 1906, to August, 1909
Bore Hole No.1 (off line)
Original Dry River Bed prior to Aug. 1909
Bore Hole No.2 (off line)
Bore Hole No.3 (off line)
Surface of Ground
River Bed Dec. 29th 1909
Clay, 509 River flowing Dec. 1909
Feb. 23d 1909
Earth
Sillar
Conglomerate
Clay and Gravel
Sand and Gravel
Water Table Dec.30th 1909 and 1906
Clay and Gravel
Concrete
Tunnel caved in beyond Branch Gallery
Lowest Water Table Aug. 10th 1909
Water Bearing Sands and Gravels
Water level March 9th 1909
Rock
Gravity Tunnel to Monterrey
Sand and Gravel
Clay and gravel face Aug. 9th 1909
Approximate Line of Bed-Rock
Water Bearing Sands and Gravels
Clay and Gravel
Large Boulders
0
100
200
300
HORIZONTAL SCALE
10 5 0 10 20 30 40 50 60 70 80 90 100 Meters
VERTICAL SCALE
10 9 8 7 6 5 4 3 2 1 0 10 20 Meters

SECTION OF INFILTRATION GALLERY
SAN GERONIMO GRAVITY SUPPLY.

Pipe Laying.—The pipe-laying gang was composed of 7 Mexicans under the direction of an American foreman, who was in charge of several gangs. One gang could lay daily from 60 to 73 m. (from 100 to 120 pipes). The following was the ordinary pay-roll for one gang:

1 Foreman at 8 pesos (proportion)........	2.00	pesos.
1 Pipe layer at 3 pesos.....................	3.00	“
1 Pipe layer's assistant at 2 pesos..........	2.00	“
1 Cement mixer at 2 pesos................	2.00	“
2 Outside plasterers at 2.50 pesos..........	5.00	“
2 Inside plasterers at 2.25 pesos...........	4.50	“
1 Water boy at 0.50 peso..................	0.50	“
Total............................	20.00	pesos.

This brings the average cost of laying the pipes to 32.8 cents per lin. m.

The pipes were jointed with 1:2 cement mortar, the outer joint being rounded over both pipes for a width of 12½ cm. (5 in.) and a height of about 19 mm. (¾ in.). In making these joints the pipe layers wore rubber gloves. The joints were kept moist, and the trench was back-filled with fine, screened material to a depth of 10 cm. above the top of the pipe. Inside, the joints were carefully caulked with cement and rendered smooth, the plasterers working continuously along with the pipe layers, doing from 20 to 35 m. at a time. Water had to be conveyed to the trenches by barrels on burros, and during the dry season it was sometimes carried 5 or 6 km.

Bridges.—The line as laid out passed over many gulches and dry arroyos, and these were crossed with reinforced concrete bridges of varying spans and heights, two being shown on Plate CLXXXII.

These bridges were formed of continuous horizontal girders, 1.10 m. deep and 1 m. wide, with a cantilever overhang at the abutments, varying in length from 1 to 2 m., so as to avoid settlement between the pipes and the bridges. The bottom reinforcement consisted of from 2 to 6 twisted bars of mild steel, varying in different spans from 12.7 to 19 mm. (½ to ¾ in.) in diameter. The turned up bars were 28½ mm. (1⅛ in.) in diameter; they were placed on either side, carried over the upper part of the beams, and continued along the end for the overhanging part of the girder. These bars, when not obtainable of the full length, were spliced with a lap of 1.2 m. with No. 6 galvanized-steel wire. The vertical stirrups were 4.7 by 25.4 mm. ($\frac{3}{16}$ by 1 in.), of mild steel; they were equally spaced 30.5 cm. (12 in.) apart, and carried all around the girders, lapping at the center about 15 cm. (6 in.), all the steel being carefully wired together before placing the concrete.

The general type of the piers and abutments is shown by Fig. 1, Plate CLXXXII, and varies in height with practically every bridge, the foundations in every case resting on hard rock. The concrete for the girders was a $1:2\frac{1}{2}:3\frac{1}{2}$ mixture, the crushed stone used having all passed a mesh of 19 mm. ($\frac{3}{4}$ in.). The piers were of $1:3\frac{1}{2}:5\frac{1}{2}$ concrete, and heavy "displacers" were embedded within them.

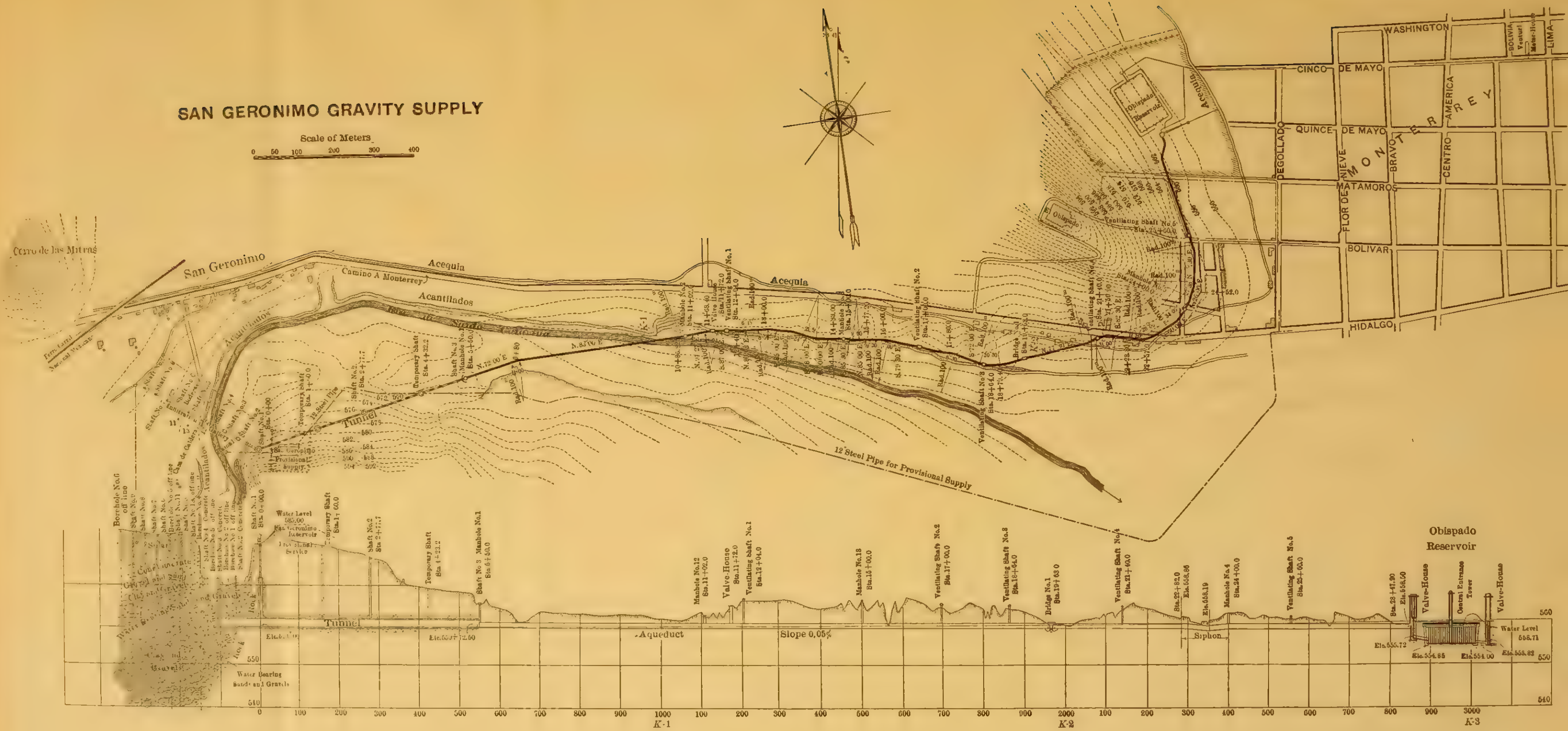
The concrete was placed after the pipes had been laid through the form by the pipe contractor, the joints being kept clear of the bottom to the required distance by small moulded concrete blocks. The tops of the girders were moulded to a slightly segmental form. The bridges were all kept watered for about 15 days, and the forms were not struck for 28 days after placing. At Station 13.4 the pipes were carried over a picturesque arroyo on a elliptical arched bridge (Fig. 2, Plate CLXXXII) of 11 m. clear span.

The abutments of all bridges were protected by rubble walls in cement mortar carried up 60 cm. above the tops of the girders.

The contract price for the concrete work of these bridges, the Company furnishing the steel and cement, was 14 pesos per cu. m., and for placing reinforcing steel 35 pesos per metric ton (2 204 lb.).

There are 49 single-span bridges, the larger spans being 9.10 m.; 8 two-span, and 11 three-span bridges, their total length, including the overhang, amounting to 870.50 m., or $4\frac{1}{2}\%$ of the whole length of aqueduct.

Concrete Aprons.—At 76 points there were small depressions which did not necessitate the construction of bridges, and at these places the pipes were encased in blocks of concrete carried up the hillside in the form of an apron having small abutment walls from 1 to 2 m. apart. This also served to protect the pipes from scouring action during rainstorms. At the upper end of the line, near the intake, the pipe had to be protected by concrete continuously for a distance of about 300 m., in order to prevent damage from falling rocks.



SAN GERONIMO GRAVITY SUPPLY

Ventilators and Manholes.—Along the route of the concrete pipe there are 27 ventilators, one of which, together with an entrance manhole, is shown by Fig. 1, Plate CLXXXIII. They consisted of simple concrete columns, 3.35 m. high, above the ground line, the interior of the shafts being formed of fire-clay pipes, 15 cm. (6 in.) in diameter. At each ventilator the pipe was cut and a block of concrete the width of the trench filled in as a foundation. Entrance manholes were also placed at 49 points, at 27 of which they immediately adjoined the ventilating columns.

Estanzuela Tunnel.—At 1 560 m. from the intake at Estanzuela, the conduit is laid through a tunnel 281 m. long. The tunnel was driven through hard calcareous strata from the open cuttings at each end. The inner dimensions were trimmed to approximately 2 m. high and 1½ m. wide. At the ends of the tunnel the rock was moderately easy to take out, but the inner section was very hard and difficult to blast. Ordinary hand drilling was adopted, and the actual cost of driving varied from 28 pesos per lin. m. at the ends to 50 pesos in the center.

The pipes were laid through the tunnel in the ordinary way, and back-filled from the center, so as to give a cover of about 45 cm. above to protect them from falling pieces of shale.

Siphons.—It has already been mentioned that there are 6 cast-iron pipe siphons. The head on these varies between 10 and 38 m. All are provided with special inlets and outlets, forming combined overflow and ventilating chambers, and have wooden hand-sluices to divert the water when necessary. The bottoms of all siphons are provided with 20-cm. cast-iron scour-out pipes, fitted with valves, and carried down to a lower point to obtain a free outlet. The valve-boxes are protected by being placed in heavy concrete chambers carried up above the level of ordinary floods.

The siphons are formed of cast-iron socket pipes, 3.65 m. (12 ft.) long, caulked in the ordinary way with lead joints. The thickness of the 45.7-cm. (18-in.) pipes is 19 mm.; that of the 50.8-cm. pipes is 21 mm. On the steep hillsides the pipes are anchored securely to the rock in concrete blocks reinforced with heavy iron chains. In some cases these siphons were difficult of access, but ox-teams hauled the pipes in a very efficient and satisfactory manner.

Overflow Chambers.—The ordinary overflows, of which there are 14, are similar in design to the siphon inlets.

Testing, etc.—When the line was completed it was tested for water-tightness, and the loss was found to be about 5%, part of which was probably due to absorption. At a later date it was found that the waters of the Estanzuela River, which contain 150 parts of calcium carbonate ($CaCO_3$) per million, deposited a very fine film of lime on the interior of the pipes, completely filling any pores there might have been. At the present time there is no measurable leakage, thus proving that the character of the work is very satisfactory.

The water was turned into the conduit on June 11th, 1908, and delivered to the city on the following day through a by-pass, before the reservoir was completed.

The pipe line is patrolled daily by an inspector with the authority of a gendarme, so as to prevent the unlawful abstraction of water, a very necessary precaution in so dry a country.

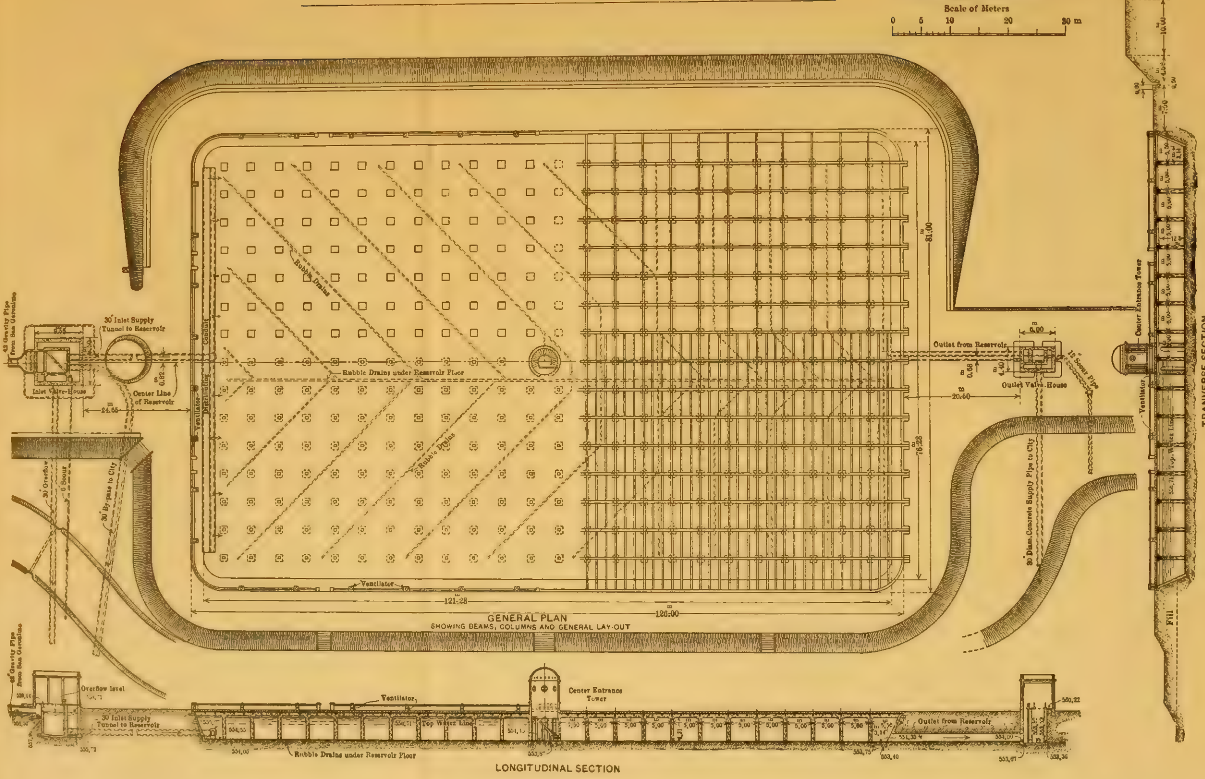
South Distributing Reservoir.

The distributing reservoir for the Estanzuela supply is at Guadalupe, on the foot-hills to the south of the Santa Catarina River, about 2 km. from the center of the city. The reservoir is a covered one, of reinforced concrete, and its capacity is 38 000 000 liters (10 000 000 U. S. gal.).

Excavation and Embankment.—The heavy slope of the ground at the selected site made the circular form the most desirable. On the low side the ground was excavated about 2 m. below the original ground line, while the excavation at the upper part of the slope was about 12 m. deep. The excavated material consisted chiefly of sillar and limestone conglomerate, which when broken up forms a calcareous clay of an excellent character for the formation of embankments, when proper care is taken. The dimensions fixed for the internal diameter of the finished concrete work of the reservoir were: 81 m. (265.68 ft.) at the top, and a depth of water of 9 m., with sides sloping 55 in 100.

Fig. 10 is a plan of the reservoir, with a cross-section of the excavation and embankment. On the lower side the original ground line was cut down in steps, and all loose earth, roots, etc., were carefully removed. The floor of the reservoir was chiefly sillar conglomerate, a hard material that required a considerable amount of blasting for its removal. The embankments were formed in 10-cm. layers

GENERAL PLAN AND SECTIONS, OBISPADO RESERVOIR

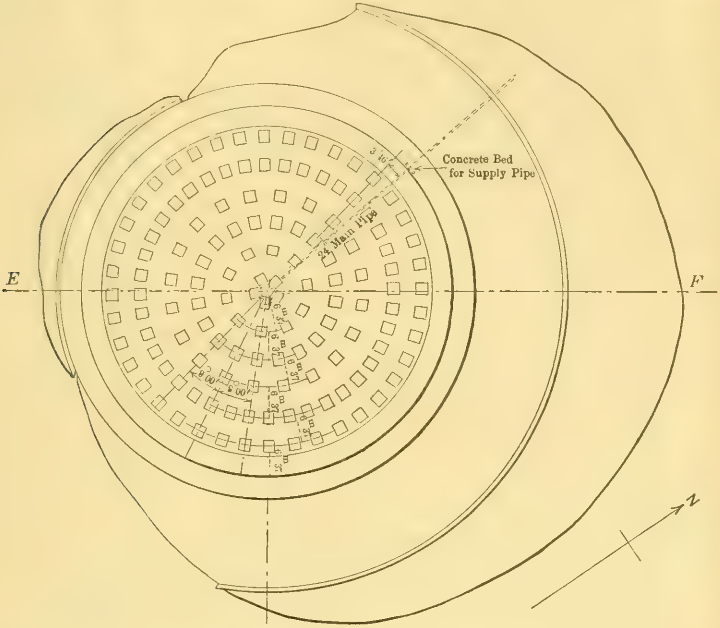


GENERAL PLAN
SHOWING BEAMS, COLUMNS AND GENERAL LAY-OUT

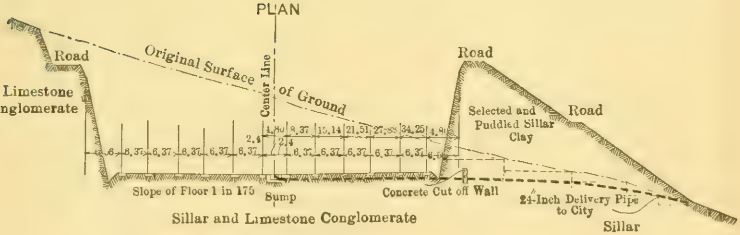
LONGITUDINAL SECTION

TRANVERSE SECTION

of sillar and conglomerate broken into small fragments and then rolled with 3-ton sectional rollers drawn by teams of 4 and 6 mules, which assisted in disintegrating the mass thoroughly, and produced by constant wetting a homogeneous and compact clay. The excavation and embankment were left so that 15 cm. of trimming could be done at a later date, immediately prior to the lining of the reservoir. The excavated material amounted to about 34 000 cu. m., and, of this quantity, 31 500 cu. m. were used to form the embankment; the



PLAN



SECTION *E-F*

SOUTH RESERVOIR
PLAN OF EXCAVATION
FIG. 10.

remainder was taken to a spoil bank immediately adjoining, the black earth stripping being separated and reserved for covering the reservoir, etc. The contract prices for the excavated material placed in the embankment were:

	Pesos per cubic meter.
Class 1.—Material which could be removed by plows and scrapers	0.60
Class 2.—This consisted chiefly of "sillar"	1.09
Class 3.—Limestone conglomerate (requiring blasting)	1.65.

The prices (for the same classification) for material taken to the spoil bank, were 0.40, 0.80, and 1.40 pesos, respectively. Of the material taken out, 15% came under No. 1 classification, 80% under No. 2, and 5% under No. 3.

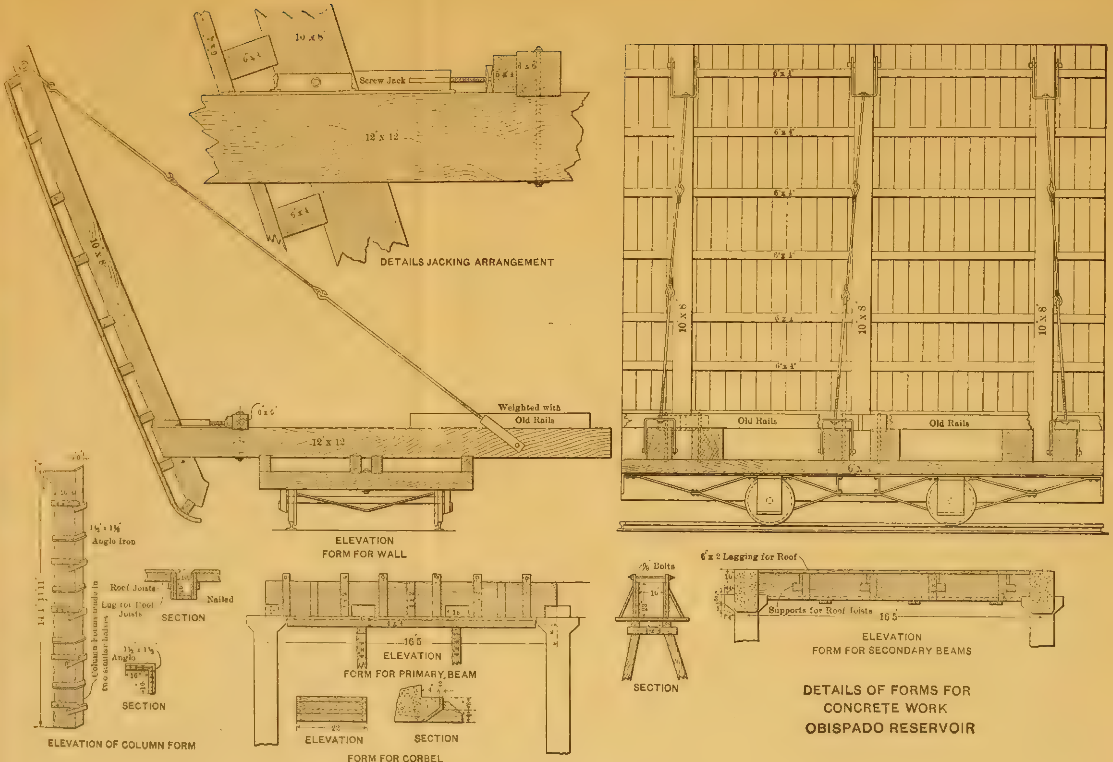
The excavation was begun at the end of May, 1907, and completed in January, 1908, by Scott and Lee, the contractors. The embankments were then allowed to stand until the beginning of July, 1908, to permit the whole to become thoroughly settled and consolidated prior to beginning the lining. In July the work of trimming the embankments and excavating for the foundations of the reservoir columns was commenced, under the Company's own administration, which completed the entire work.

Concrete Lining and Roof.—The general arrangement and details of the side-walls, columns, and roof are shown on Plates CLXXXIV to CLXXXVII. The principal feature consists in dividing the reservoir into radial sections and supporting the roof on 135 primary and 670 secondary beams, from 135 columns, spaced as follows:

Outer ring, at 34.25 m. from center	40 columns.
2d " " 27.88 " "	40 "
3d " " 21.51 " "	20 "
4th " " 15.41 " "	20 "
5th " " 8.77 " "	10 "
6th " " 2.40 " "	5 "
Total	135 columns.

The inner bottom diameter of the reservoir is 70.32 m. (230.64 ft.); the upper inside diameter is 81 m. (265.68 ft.); the water depth at the overflow level is 9 m. (29½ ft.).

PLATE CXCII.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.



DETAILS JACKING ARRANGEMENT

ELEVATION
FORM FOR WALL

ELEVATION OF COLUMN FORM

SECTION

SECTION

ELEVATION
FORM FOR PRIMARY BEAM

ELEVATION

SECTION

FORM FOR CORBEL

SECTION

ELEVATION
FORM FOR SECONDARY BEAMS

DETAILS OF FORMS FOR
CONCRETE WORK
OBISPADO RESERVOIR

The roof was designed to carry a dead load (the earth cover) of 150 lb. per sq. ft., and a live load of 100 lb. The maximum compressive fiber stress in the concrete was assumed at 550 lb. per sq. in. for the beams, and at 350 lb. for the columns, a low figure, because of their eccentric loading. The tensile strength of the steel was taken at 14 500 and 16 000 lb. per sq. in. The twisted steel used for the column reinforcement was made at the local steel plant, but for the beams, etc., a twisted lug bar, of higher quality and a greater permissible tensile stress, was used. The total quantity of steel used was 178 tons. It was calculated that the load on the column foundations would not exceed 1¼ tons per sq. ft. With the exception of the side-wall and floor, all the concrete was reinforced with steel, of the sizes and spacing shown on Plate CLXXXIV.

General Construction and Erection Scheme.—The question of ordinary forms, requiring very heavy timber work, was a serious one, as suitable lumber is very expensive in Mexico; and the necessity of finishing this reservoir before the end of the first term allowed under the concession, which expired on December 31st, 1908, led to the adoption of what the writer believes is an original scheme for so large a structure. This scheme was to cast the columns in short sections, mould the radial and secondary beams as separate members, and then place them in position with derricks. At the same time, in the case of the beams, it was important not to sacrifice either the benefit of that part of the slab which is ordinarily assumed to act as a part of the beam, or the additional strength due to continuity; and, in case of the columns, the strength due to the reinforcement extending from the foundation to the beams.

The **T**-beam section was secured by notching the tops of the moulded members, with notches 10 cm. deep, throughout the lengths of the beams, as shown on Plate CLXXXIV. A computation of the maximum flange increment shows that these notches are sufficient to transfer the flange stresses to the stem, but, for additional security, flat steel bars were bent to a **Z**-shape, and embedded in the top of the beam about 60 cm. apart. Continuity in the beams was secured by carrying the steel to the tops of the beams over all supports, and, after erection, concreting them into the roof slab. The secondary beams, after casting, were dropped into recesses left in the radial beams for the purpose.

Concreting, Mixing, etc.—The radial beams and column sections were cast as nearly as possible under their ultimate positions; the secondary beams were cast outside and immediately adjoining the reservoir.

The rock and sand was brought from the Company's crushing plant, in 3-cu. yd., side-dump cars, running on a 30-in. track by gravity a distance of 1 km., the last 150 m. requiring hauling with 6 mules. The cars returned all the way to the crusher by gravity. These cars dumped the material into bins on the high ground above the reservoir; from there it was hoppered into cars which carried to the mixer all the material for one batch of concrete. Two No. 1 Smith mixers were used, and from 25 to 30 batches per hour could be handled in each machine.

The concrete was transported from the mixers to place in ½-cu. yd., 18-in. gauge, swivel, steel dump-cars pushed by two men. All the concrete used in the bottom of the reservoir, for the main beams, columns, and floor, amounting to about 2 460 cu. m., was dumped through a chute into smaller cars. The chute had so many baffle-plates and bolts that it resembled a gravity mixer, but, although it was 12 m. long, it effectively prevented the separation of the materials.

Concrete Placing and Moulding.—The square foundations for the columns were deposited *in situ,* a recess being left for the reception of the pedestals, which were moulded in place afterward. The capitals and pedestals were cast in one piece, and the columns in 1.21-m. (48-in.) sections, eight 5-cm. holes being left in them by using wrought-iron pipes, held in place by templates and removed when the castings were about 3 hours old. The columns were erected by threading them on the 15.8-mm. (⅝-in.) reinforcing rods, which extended from the pedestals up through the capitals. The rods were in two lengths, arranged to lap alternately at one-fourth, the center, and three-fourths of the height of the columns. In erection, a light timber frame was used in conjunction with the derrick, and, as the columns were placed, the reinforcing steel was grouted solid with 1:2 cement mortar.

All the erection was done with a combined stiff-leg or guy derrick, having an 80-ft. boom and a 50-ft. mast, and fitted with a 30-h.p. Lambert hoisting engine. The derrick was erected seven times at the circumference, and its final position was on top of the center columns. The moving of the derrick a distance of about 45 m. and its subse-

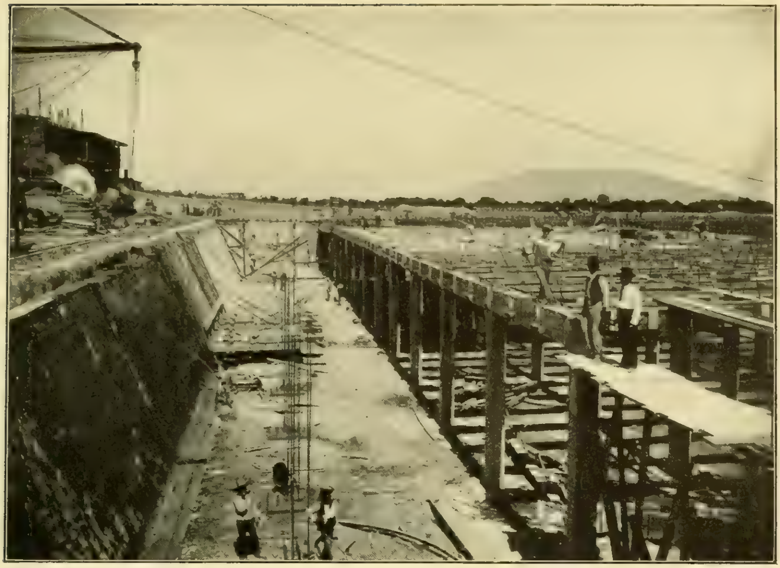


FIG. 1.—CONSTRUCTION OF WEST SIDE-WALL OF OBISPADO RESERVOIR.

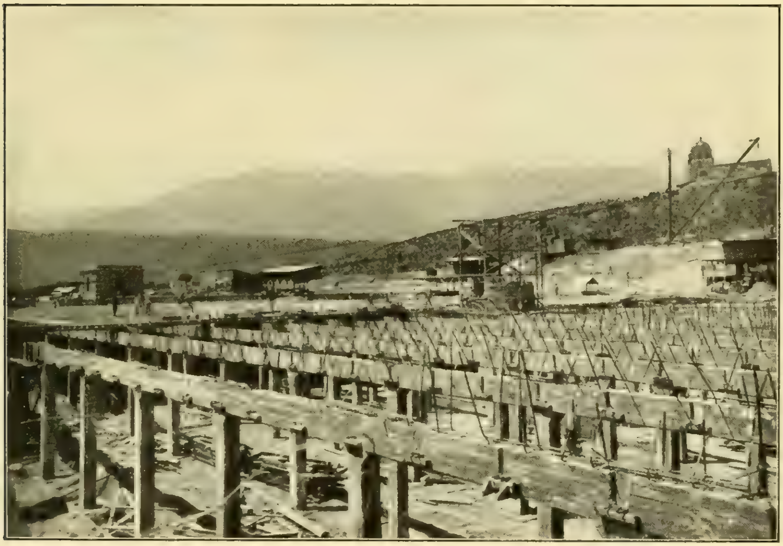


FIG. 2.—PRIMARY BEAMS AND COLUMNS, OBISPADO RESERVOIR.

quent erection occupied usually about 48 hours. The erection work was carried on continuously, day and night, the placing of the whole of the radial and secondary beams and columns occupying 2½ months.

Forms.—As the erection scheme was designed to reduce the cost of forms, economical construction was of considerable importance. The wall was formed in 40 panels, about 6 m. wide and 11.27 m. high. The chief object in arranging them in this manner was to permit an expansion joint, 30 cm. wide, at each panel; this joint was not filled until after the completion of the roof, when the temperature inside the reservoir was uniform and not subjected to such great fluctuations as if exposed alternately to the hot sun and comparatively cool nights. The range of temperature during the construction period sometimes amounted to 80° Fahr. in 24 hours.

The expansion joints were left to the last, when a uniform temperature of about 70° inside permitted the filling of the joints, thus avoiding all trouble from expansion cracks.

The forms are shown in detail on Plate CLXXXV. They consisted of shutters stiffened with four trapezoidal trusses. The bottom posts of the trusses were fixed in holes formed in the foundation block; they were propped back from the embankment at the top, and secured to anchorages by iron rods.

Six sets of these forms were used to construct the whole wall. The concrete was placed in position through stove-pipe chutes, 20 cm. in diameter, in continuous layers, the workmen treading and spading it well as it was deposited. The forms were allowed to remain 4 or 5 days, and were then struck and removed to another section. The pedestals and capital forms were of lumber, and five of each were used to cast the total number required. In the column sections the outer steel forms used in the manufacture of the Estanzuela pipes were adapted for this purpose. The radial beam forms, shown on Plate CLXXXV, were arranged with internal wedge-shaped blocks to mould accurately the recess for the secondary beams. The bottom forms were left attached to the beams for 28 days, but the sides and ends were removed after 24 hours. Eight forms were sufficient for the whole 135 beams.

For the secondary beams, 29 forms were used for the 670 beams, the bottom lumber also being left until they were mature for handling.

By referring to the cross-section of the secondary beam, it will be noticed that it is jug-shaped, shelves being left on either side for the support of the roof forms, which were placed after the secondary beams had been properly grouted to the radial ones. The lagging was laid diagonally, so that the short diameter was slightly greater than the distance between the beams. This greatly facilitated the removal of the lagging, as it was merely necessary to strike the wedge-shaped fillets beneath, and turn them clockwise, after tearing out the end lagging.

The writer believes that the adoption of forms of this type, rather than the ordinary kind, led to a saving of lumber of about 400 000 ft. b. m. During the erection and placing of the concrete, all the joining surfaces were carefully picked and cleaned, particular care being taken at the junction of the secondary with the radial beams, and the upper surfaces of all beams before laying the roof slab.

After the greater part of the roof was completed, the floor was laid in those sections where it was protected from the sun's rays. The concrete was placed in two 15-cm. thicknesses, and the work was carried on night and day, without any joints. The laying of the floor occupied 8 days, or an average of nearly 100 cu. m. daily.

Proportions of Concrete.—All the concrete work was brought to a smooth face by careful spading, no plastering being used throughout the reservoir, except in the superstructures. The work was kept well watered in every case for about 15 days. The whole of the concrete work in connection with the reservoir was completed in 5½ months. The concrete for the columns and foundations was a 1 : 3 : 5 mixture, the aggregate consisting of equal parts of 19-mm. (¾-in.) and 38-mm. (1½-in.) crushed stone. The remainder of the concrete, except that for the roof, was a 1 : 2 : 4 mixture, the aggregate also consisting of equal parts of 19- and 38-mm. stone. With the exception of a short length of the side-walls, the sand used was that manufactured by the Company. When the crushing plant was unable to produce all the sand required, the Hornos sand (see Table 3) was used in the side-walls in equal proportions with the crusher sand.

Reservoir Outlet and Entrance Tower.—The outlet, 61 cm. (24 in.) in diameter, leads from a well in the center of the reservoir and passes under the floor and embankment to an outside valve-pit, 89 m. from the center. This pipe was laid in a trench in a solid cutting before the construction of the embankment, and was encased in 1 : 4 : 8 concrete.

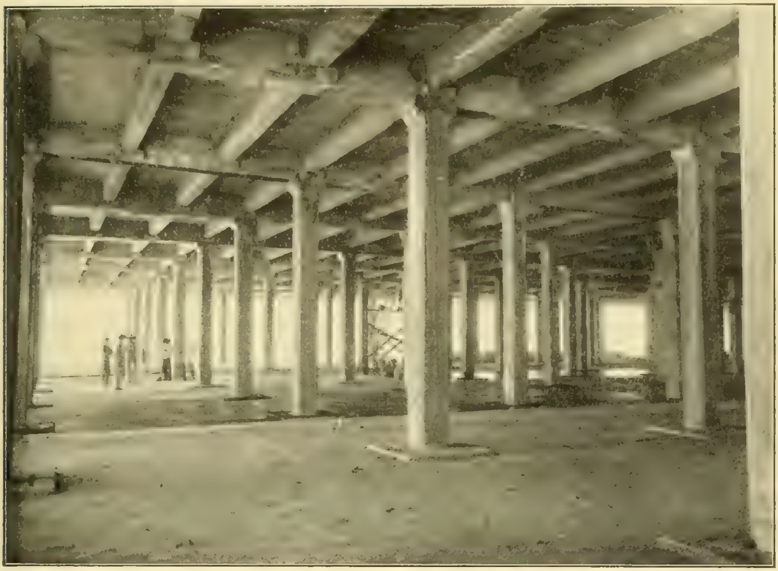


FIG. 1.—PREPARING FLOOR FOR CONCRETING, OBISPADO RESERVOIR.

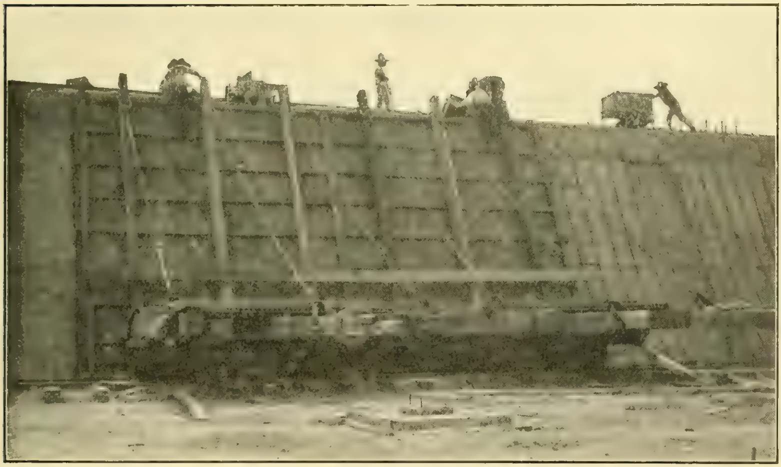


FIG. 2.—TRAVELING SIDE-WALL FORM, OBISPADO RESERVOIR.

Where it passes under the embankment a 1:2:4 concrete cut-off wall, 3.6 m. wide, 2.5 m. high, and 1 m. thick, was placed across it at right angles. The cast-iron pipe is curved upward in the central well, and has a bellmouth on which rests a movable circular copper screen.

Above the outlet well, and on the roof of the reservoir, there is a central tower, giving access to the interior by a steel stairway. This tower also serves as a main ventilating shaft, and in it are arranged the guide-screens and gearing for raising them for cleaning purposes. In addition to the ventilation provided in the tower, 20 circular openings, 30 cm. in diameter, are carried through the roof of the reservoir at the circumference and into the parapet walls.

Inlet Gate-House, etc.—The inlet gate-house is above the reservoir and about 54½ m. from its center. The conduit enters at 589.00 m. above datum, and the gate-house contains the valves for controlling the inlet pipe to the reservoir, the by-pass, overflow, scour-out pipe, and the copper screens. The inlet, which is 45.7 cm. (18 in.) in diameter, is of cast-iron flanged pipes, carried on iron hangers on the side-wall of the reservoir, and, at a point 90 cm. above the floor level, it is turned at right angles to the side-wall and carried on concrete piers to the center of the first row of columns. The end of the pipe is closed by a blank flange, and the water is deflected at right angles through two 30-cm. (12-in.) branches, for the purpose of setting up a slight circular motion as it enters the reservoir.

The valve-pit is clear of the embankment, and in it are brought together the main supply and by-pass pipes on which are placed two 61-cm. (24-in.) sluice-valves; and between them there is a 20-cm. (8-in.) scour-out pipe, for emptying the reservoir into an adjoining arroyo. The arrangement of the valves gives complete control over the contents of the reservoir.

Venturi Meter-House.—Fig. 11 shows the arrangement of the Venturi meter and its automatic register in a house over the main supply pipe. This house is designed to form a feature of the entrance gateway of the reservoir grounds, which cover an area of 12 hectares.

General.—The roof of the reservoir has been laid out as a garden, and the embankments are turfed. The intention is to develop the Company's land as a public park, as it commands fine views of the city and the surrounding mountains. An inspector's house has been built, and a private telephone line provides for communication with the Estanzuela intake and also with the general offices in the city.

SAN GERONIMO GRAVITY SUPPLY.

Provisional Supply.—It has already been stated that the Company began operations at San Geronimo in March, 1906, by sinking a well on the north bank of the Santa Catarina River at San Geronimo. At this point, a little later, a small steam pumping plant, sufficient to handle about 8 000 liters per min., was installed. The lowest depth to which this well was ultimately sunk in water-bearing strata, was 7 m., the normal level of the water during 1906 and 1907 never falling lower than 569 m. above datum. Tests made from time to time during 1907-08, showed that this well was capable of supplying nearly 10 000 000 liters (264 000 gal.) of water daily.

The excellent supply yielded by this well made it desirable to adopt it immediately as a provisional measure, pending the completion of the larger works forming the western source of supply. To utilize the well to its fullest extent, a reinforced concrete reservoir, of 3 000 000 liters capacity, was constructed on the south bank of the river, the top water level being 585 m. above datum, that is, at the same elevation as the proposed reservoir for the Estanzuela supply. The reservoir is 53.80 m. long, 21 m. wide, and has a water depth of 3.25 m. at the overflow level. It is excavated on a steep hill slope, and has an earth embankment on the lower side. The lining is of concrete, 20 cm. thick, and the roof is of reinforced concrete composed of flat arches springing from beams carried on 46 by 35-cm. reinforced columns. There are 68 of these columns, and they are 3 m. apart longitudinally and 5 m. apart transversely. The roof was not constructed until October and November, 1907, and prior to that time the necessity of covering the reservoir was amply demonstrated by the growth, during hot weather, of considerable quantities of green algæ, which had to be skimmed from the surface of the reservoir every few days.

The delivery pipe from the pumping plant was originally of riveted steel and was asphalted. It was 30 cm. in diameter, 2 mm. in thickness, with slip joints, and where it crossed the river it was encased in concrete. This pipe was afterward replaced by a cast-iron pipe of the same diameter. The supply pipe to the city was also of sheet steel, 30 cm. in diameter. For a part of its length it was laid in the high ground of the south bank of the river, which it crossed near the western limits of the city, and was then connected to a 30-cm. cast-iron pipe in the

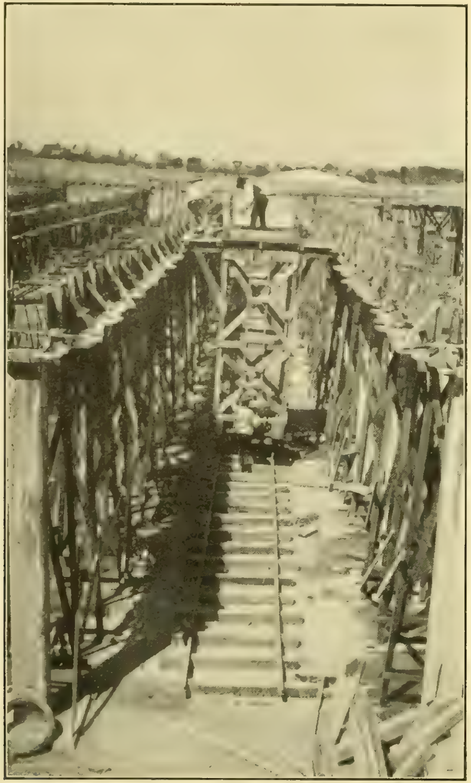


FIG. 1.—FILLING PRIMARY BEAMS FROM TRAVELING

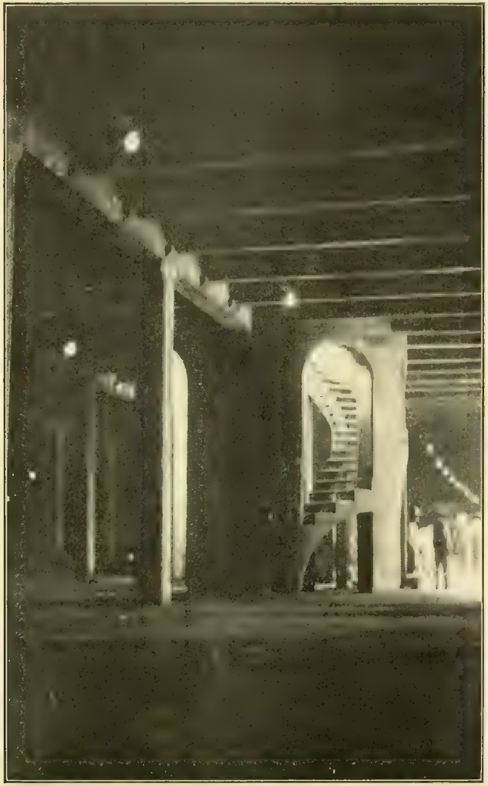
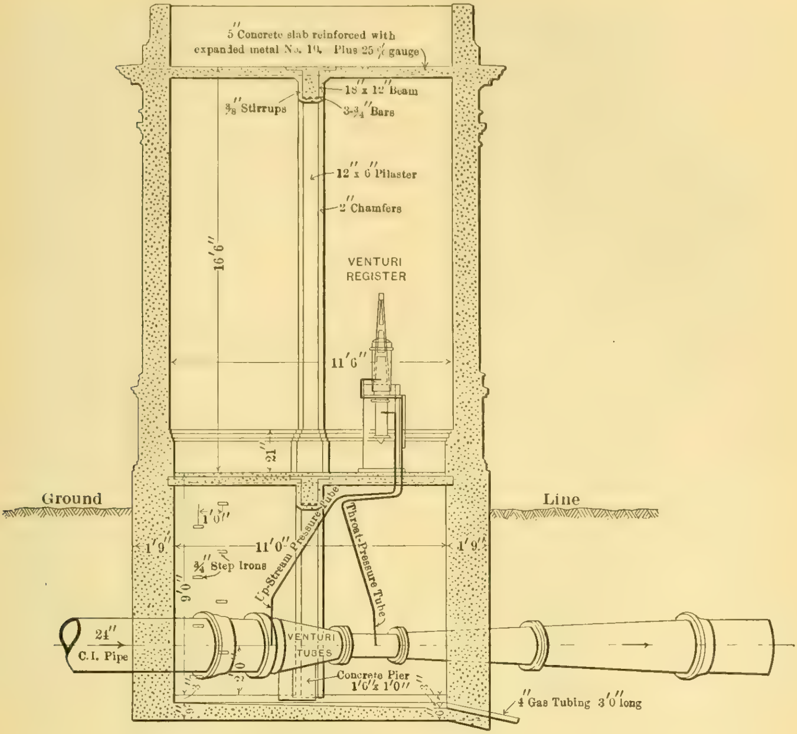
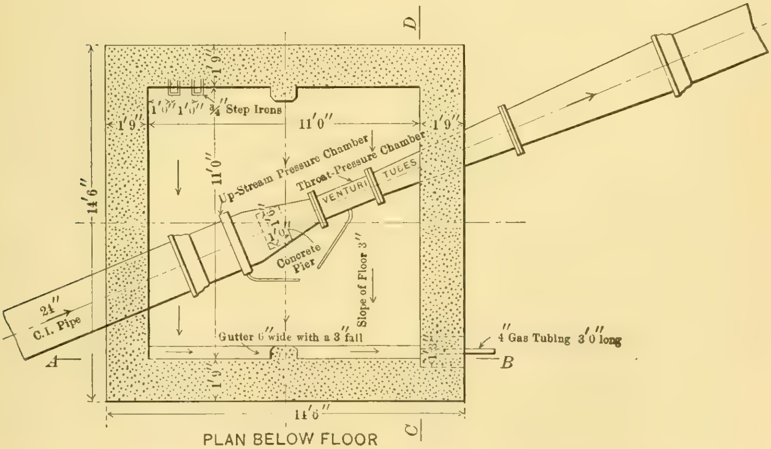


FIG. 2.—CENTRAL TOWER AND STAIRWAY, OBISPADO



SECTION A-B



PLAN BELOW FLOOR

FIG. 11.

distribution system. The total length of the pipe from the reservoir to the city distribution system was 2 850 m.

This provisional pipe continued in service from October, 1906, until August 27th, 1909, when the river portion was completely swept away, together with the provisional pump-house at San Geronimo, during the great flood in the Santa Catarina River. Fortunately, the permanent supply works were completed at the time, so that the destruction of this pipe line, which had already served its original purpose, had no effect on the supply of water to the city.

Infiltration Gallery.—The chief feature of the San Geronimo gravity supply is the infiltration gallery. By referring to the profile on Plate CLXXXIX it will be seen that at this place there is a considerable area of what is undoubtedly water-bearing gravel. The main conditions were revealed by the borings previously carried across the valley, but the profile has been corrected to show the actual conditions as established at a subsequent date by shafts. Practically, the water-bearing strata are not limited merely to the sand and coarse gravels, as the clay formation lying above and below them is full of small gravel deposits containing considerable volumes of water. The main direction of the underflow is toward the east, and the hydraulic gradient, which was established from wells sunk farther west, was found to be approximately 1%, or practically the same as the average surface of the bed of the river above the line of the infiltration gallery.

The general scheme for tapping this underflow was to drive a main gallery at the 560-m. level on a grade of 0.05%, which was sufficiently high to take the supply by gravity to the western reservoir, having a top water level at 558.75 m. above datum. This elevation is sufficient to give an excellent pressure over about 60% of the city, and a fair pressure to reach the upper stories of the highest houses, if required, over the whole supply district. From this gallery it was proposed to sink shafts at frequent intervals, for a total distance of 300 m., carrying them below the gallery level, to tap any water-bearing gravels there might be in the clay formation underlying the gravels and sands. From the main gallery it was proposed to construct branch galleries up stream on a flat gradient, so as to obtain the advantage of an increased head due to the steep hydraulic gradient of the underflow water.

In investigations of this kind, it is of first importance to have a continuous record of the level of the water plane, and Fig. 12 has been

PLATE CXCVI.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.

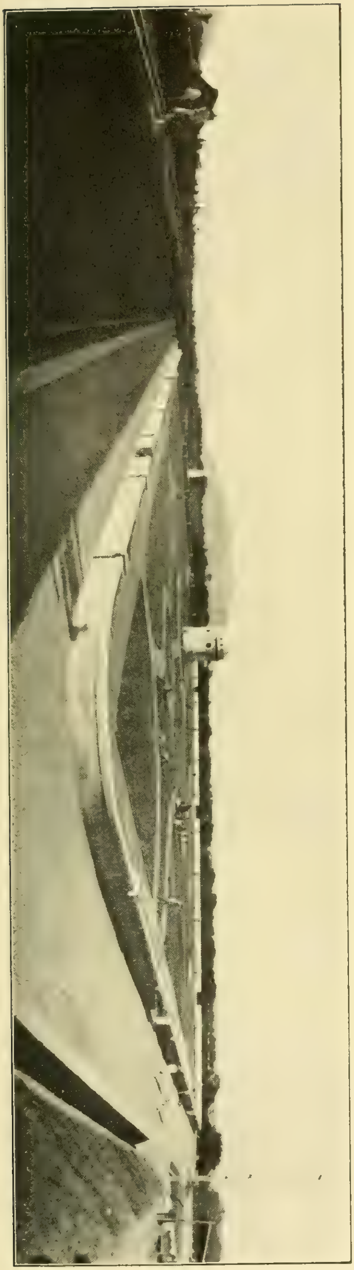
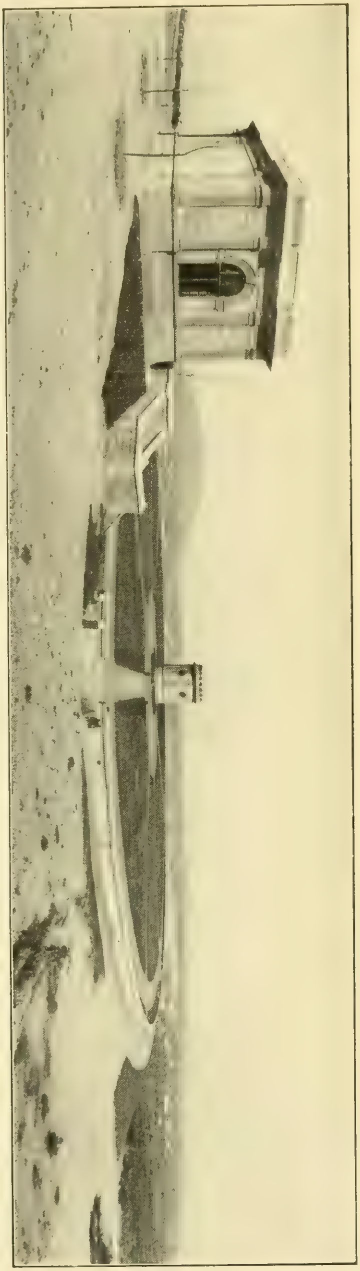


FIG. 1.—VIEW OF SOUTH RESERVOIR, LOOKING TOWARD THE CITY.



plotted to show its variation at San Geronimo from the beginning of 1905 to March, 1910. From January, 1909, to March 31st, 1910, these levels are averages of daily readings taken in 9 shafts sunk along the proposed line of the infiltration gallery. In 1902 the water plane was standing at 570.18 m. above datum, but from that date until 1905 the writer has been unable to find any records. This diagram should be examined together with the rainfall diagram, Fig. 3, and it will be noticed that the fall in the water plane drops with the general scarcity of the rainfall during 1907-08, and until July, 1909. The year previous to July, 1909, is regarded by many competent local observers to have been the longest period of extreme drought in 30 years in Nuevo León, and the evidence which the writer has been able to gather regarding stream flow in the neighborhood of Monterrey supports this view. The total rainfall at Monterrey for the year prior to July 1st, 1909, amounted to 9.98 in., or 4.16 in. less than the lowest record for any

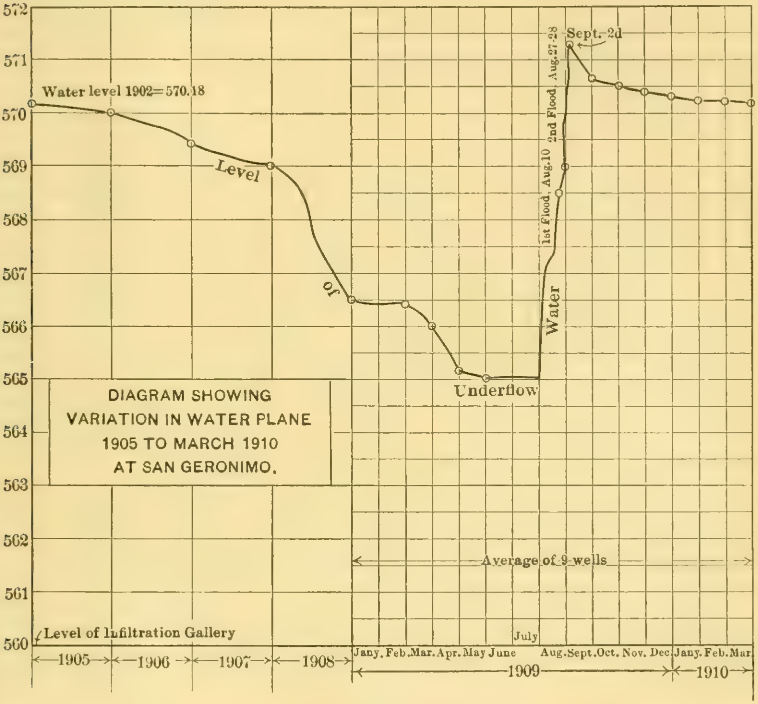


FIG. 12.

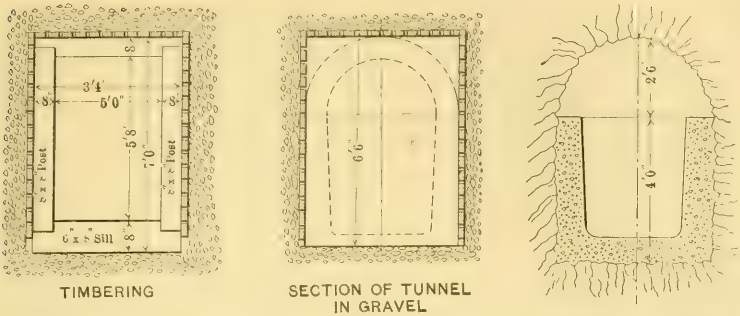
calender year since 1894, or, in other words, about 45% of the average annual rainfall.

The lowest point to which the water plane dropped was during June and July, 1909, when the levels stood slightly above 565.00 m., or 5 m. above the level of the floor of the infiltration gallery. During this period pumping tests were made in the various wells, and from these it was quite clear that the infiltration gallery, if carried far enough to meet them all, would yield a supply of from 25 000 000 to 40 000 000 liters daily. During the great rainfall of August, 1909, the water levels rose very rapidly; the heavy precipitation between August 9th and 10th caused the level to rise to 568.00 m. in about 4 days, and 6 days after the great flood of August 27th, the water level, which had continued rising gradually, reached 571.40 m., and then fell gradually until at the end of March, 1910, it was practically the same as it had been from 1902 to 1905.

It should be noticed that the readings were taken in the shafts on the high ground to the west of the present river bed, and were independent of any flow there might be in the river. During times of ordinary floods in the river, it was very noticeable that, notwithstanding the fact that the river water might be turbid to an extreme degree, the well even in immediate proximity to the river bed did not show the least sign of discoloration.

Design of Works.—Plate CXC shows the general design of the gravity scheme, which consists of a main tunnel 550 m. long and a concrete aqueduct, 1.06 m. (42 in.) in internal diameter and 2 311 m. in length, discharging into a low-service distributing reservoir at the extreme western limits of the city. The tunnel and aqueduct were laid on a gradient of 0.05%, and the latter was designed to discharge 55 000 000 liters per day (22.8 cu. ft. per sec.) if flowing to its full capacity.

Gravitation Tunnel.—This tunnel, shown on Plate CXC and Fig. 13, was completed prior to driving the infiltration gallery into the water-bearing gravel, so that the water encountered in the gallery could be easily drained off by gravity, thus avoiding a heavy outlay for pumping. The tunnel passes through various strata, the principal ones being calcareous shale, conglomerate, and gravels. The tunneling operations were carried on from 5 shafts, No. 1 being 23 m. deep, and the others varying from 20 to 10 m. The shafts in loose ground were

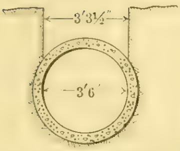


TIMBERING

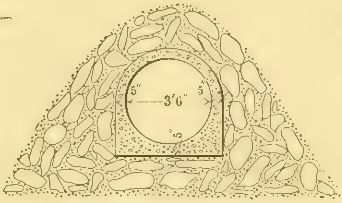
SECTION OF TUNNEL IN GRAVEL

SECTION OF TUNNEL IN ROCK

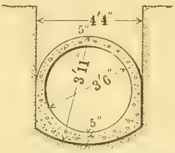
DETAIL OF GRAVITATION TUNNEL



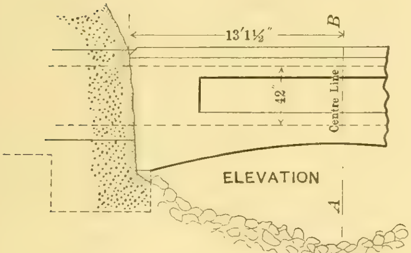
SECTION OF CONDUIT IN ROCK, TYPE *B*

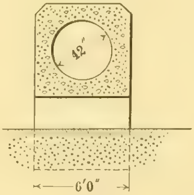


SECTION OF CONDUIT IN RIVER BED, TYPE *C*



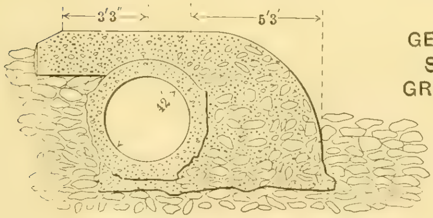
SECTION OF CONDUIT IN SOFT GROUND TYPE *A*





SECTION AT *A-B*

DETAILS OF BRIDGE AT STA. 19 + 63.0



DETAIL OF SPECIAL SECTION ACROSS RIVER

GENERAL DETAILS
SAN GERONIMO
GRAVITY PIPE LINE

FIG. 13.

timbered in the usual way, having clear inside dimensions of 2 m. Shaft No. 1, which was entirely in shale, was taken out approximately to 3.35 m. in diameter, so as to permit it to be lined with concrete having a finished internal diameter of 2.43 m.

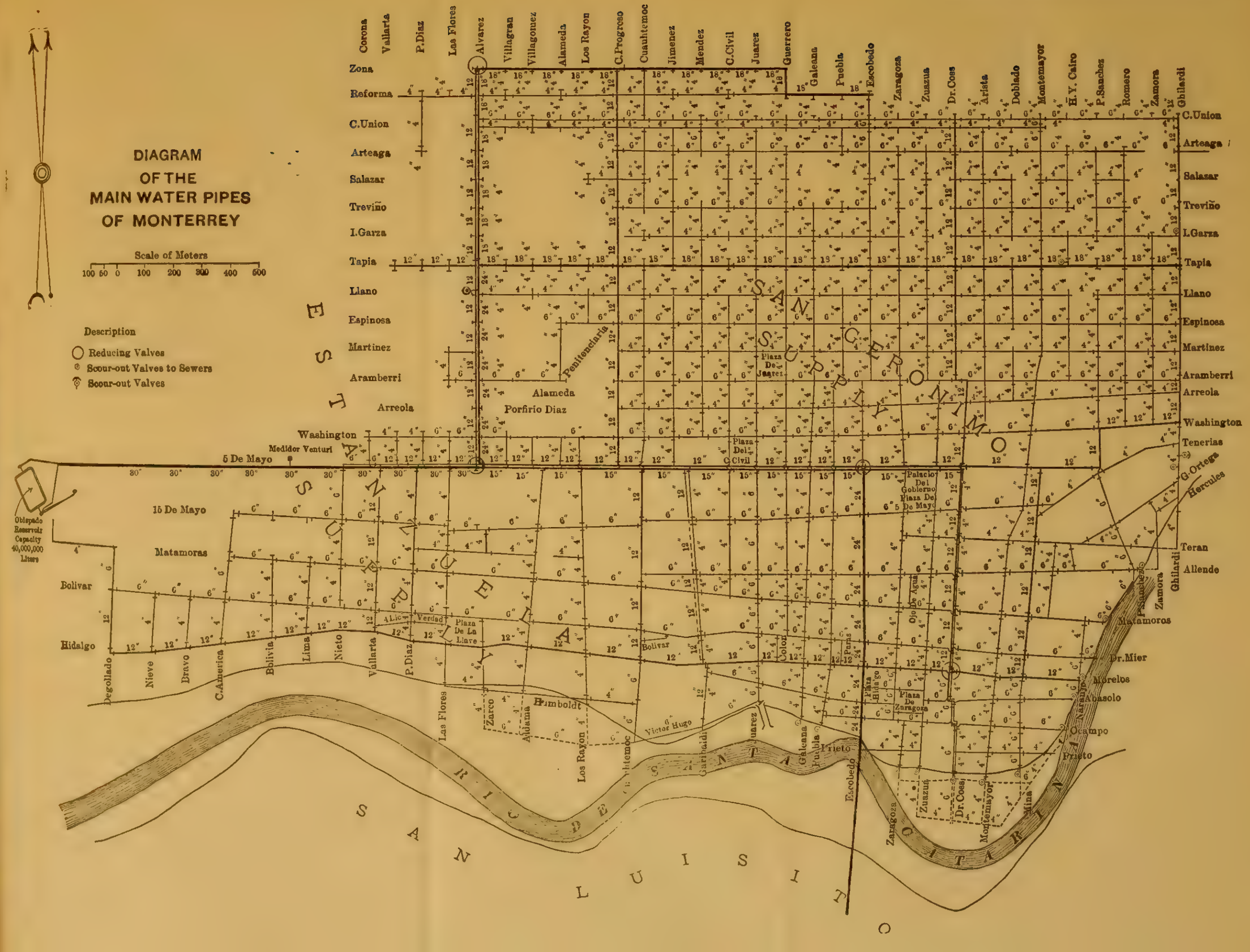
Fig. 13 shows the details of the tunnel, which was lined with concrete, the bottom and sides being approximately 23 cm. (9 in.) thick. The interior dimension is 0.91 m. at the invert level and 1.016 m. at a height of 1.22 m., the corners between the side-walls and the floor being slightly curved. The arch is formed of two rings of brickwork in cement mortar, this thickness being increased in some lengths to three rings. Where the rock was in good condition, and not likely to disintegrate easily, the arch, for a distance of 90 m., was left unlined. Of the total distance of 550 m., careful timbering was required for 300 m. In lining the timbered portion of the tunnel with concrete, all the timber was removed, except in loose ground, where the laggings were left in position.

While the tunnel was being driven, a start was made to drive the north end of the infiltration gallery, which was in rock for a distance of 44 m. Water appeared at about 35 m., and then the work was temporarily suspended until the gravitation tunnel was completed and a length of the aqueduct had been constructed far enough down stream on the north bank of the river to permit of draining direct to the river. This point was reached at 1 170 m. from Shaft No. 1, and there a temporary overflow chamber was constructed.

When the tunnel was completed, the two intermediate shafts were filled up, the remaining three being retained permanently. Shafts Nos. 2 and 3 were lined with concrete, 76 cm. (30 in.) in internal diameter, and 23 cm. thick. They were domed at the top to form circular openings to receive cast-iron covers. Progress on this tunnel was slow, taking from December, 1907, to November, 1908, to complete, owing chiefly to difficulties with an incompetent contractor. The contract was subsequently transferred to Mr. John Phillips, of Mexico City (who was also the contractor for the aqueduct), who completed it satisfactorily.

Continuation of the Infiltration Gallery.—When the aqueduct (to be referred to again) was completed as far as 1 170 m. from Shaft No. 1, the driving of the infiltration gallery, which was 2 m. high and 1½ m. wide, was continued until gravel was encountered in the roof, at 44 m.

PLATE CXCVII.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.



from the shaft. At this point the rock dipped at an angle of 45°, and the gravels contained quantities of large boulders mixed with fine sand; immediately after encountering the gravel, a flow of about 90 liters per sec. was met, evidently coming through from a pot-hole in the shale. This quantity diminished in about 10 days to about one-fourth, but gradually increased again as the driving proceeded. The operations of driving the tunnel from 44 m. forward were begun in the dry season, in February, 1909, and the gravel was encountered for a distance of 24 m., or up to 68 m. from the shaft. The center of this gravel bed was about 30 m. south of the old river channel, which had been continuously dry at the surface for several years. Up to 68 m. the work was very difficult, owing to the upper part being of loose gravel and the lower in very contorted shale. The timbering of the tunnel in the full gravel section consisted of heavy square settings, 1 m. apart. At 68 m. the clay and gravel formation was met, and the rate of progress then was about 4 or 5 m. a week. A short branch gallery was also driven about 7 m. up stream near Shaft No. 2. The total distance the infiltration gallery was carried from Shaft No. 1, was 100 m., when the floods of August, 1909, caused its suspension.

During the progress of the gallery, attempts were made to sink a 3½ by 2-m. shaft at a point along the line of the infiltration gallery, about 130 m. from Shaft No. 1, but water in such abundance was encountered that it was practically impossible to sink it in the ordinary way more than about 6 m. deep, the quantity of water to be dealt with amounting to about 20 000 000 liters daily. Seven shafts were then sunk in the high ground to the north of the river, five of these being on the line of the gallery and two 30 m. westward. They were sunk during the dry season prior to July, 1909. These were ordinary timbered shafts, 2 m. square between the walings, and were carried to the depths shown on Plate CLXXXIX. In Shafts Nos. 5, 6, and 7 the water was flowing with a considerable velocity, while Shaft No. 9 seemed to have penetrated a different water plane and one which was probably independent of that showing in any of the other shafts, in which the water was practically at a uniform level. The evidence obtained showed that if the gallery could be carried to Shafts Nos. 6 or 7 a great abundance of water would be intercepted. Owing to the difficulties of sinking ordinary shafts in the wide river channel, circular shafts were put down. These were 1.37 m. in internal diameter and 23 cm.

thick, and were of concrete reinforced with No. 10 vertical rods, 19 mm. in diameter, tied together with No. 6 wire. These shafts were provided with steel cutting edges.

Shaft No. 2 was sunk to a depth of 1 m. below the infiltration gallery level, No. 3 within 2 m., and No. 4 within 4 m., before August, 1909. The shafts were sunk by digging them out and loading them at the top, the top of the shafts being kept generally 3 m. out of the ground. Shaft No. 3 encountered great volumes of water, and, in order to enable sinking operations to proceed, a pumping shaft, 2¼ m. square, was sunk a little west of it to draw off the water. Notwithstanding the fact that the prolonged period of drought had lowered the general water plane in all the shafts to 565.00 m. above datum, the difficulties of handling the water even at that level were considerable. At the beginning of August the work was progressing very satisfactorily, but the extraordinary rainfall of that month caused the work to be shut down temporarily.

Effect of the Floods in the Santa Catarina River.—The area of the water-shed of the Santa Catarina River above Monterrey is about 1 410 sq. km. (544 sq. miles), and its area at San Geronimo, owing to its configuration, is practically the same. Its general character has already been referred to. On the night of August 10th and early on the morning of August 11th, a big flood came down the river, flowing at its maximum about 1 130 cu. m. (40 000 cu. ft.) per sec., due to the heavy rainfall (Fig. 4). This flood carried away all the temporary staging around the shafts, seriously wrecking the temporary pumping station, as well as destroying the 30-cm. cast-iron pipe, notwithstanding the fact that it had been encased in a block of concrete 3 m. wide and 1½ m. thick right across the river; but no damage was done to the infiltration gallery or to the shafts in the river channel. The effect of the flood on this pipe is shown by Fig. 2, Plate CCIX.

Following this flood, which had caused the loss of 14 lives in the city, 3 miles below San Geronimo, there was practically no rain for 13 days. Then, on August 25th the second heavy precipitation began and continued until August 29th, the details being shown on Fig. 4.

This precipitation, therefore, fell on a water-shed which was completely saturated, as it had already absorbed a large proportion of the 13.38 in. of rain which fell during August 10th and 11th; and at every point along the river, prior to August 25th, springs were issuing forth.

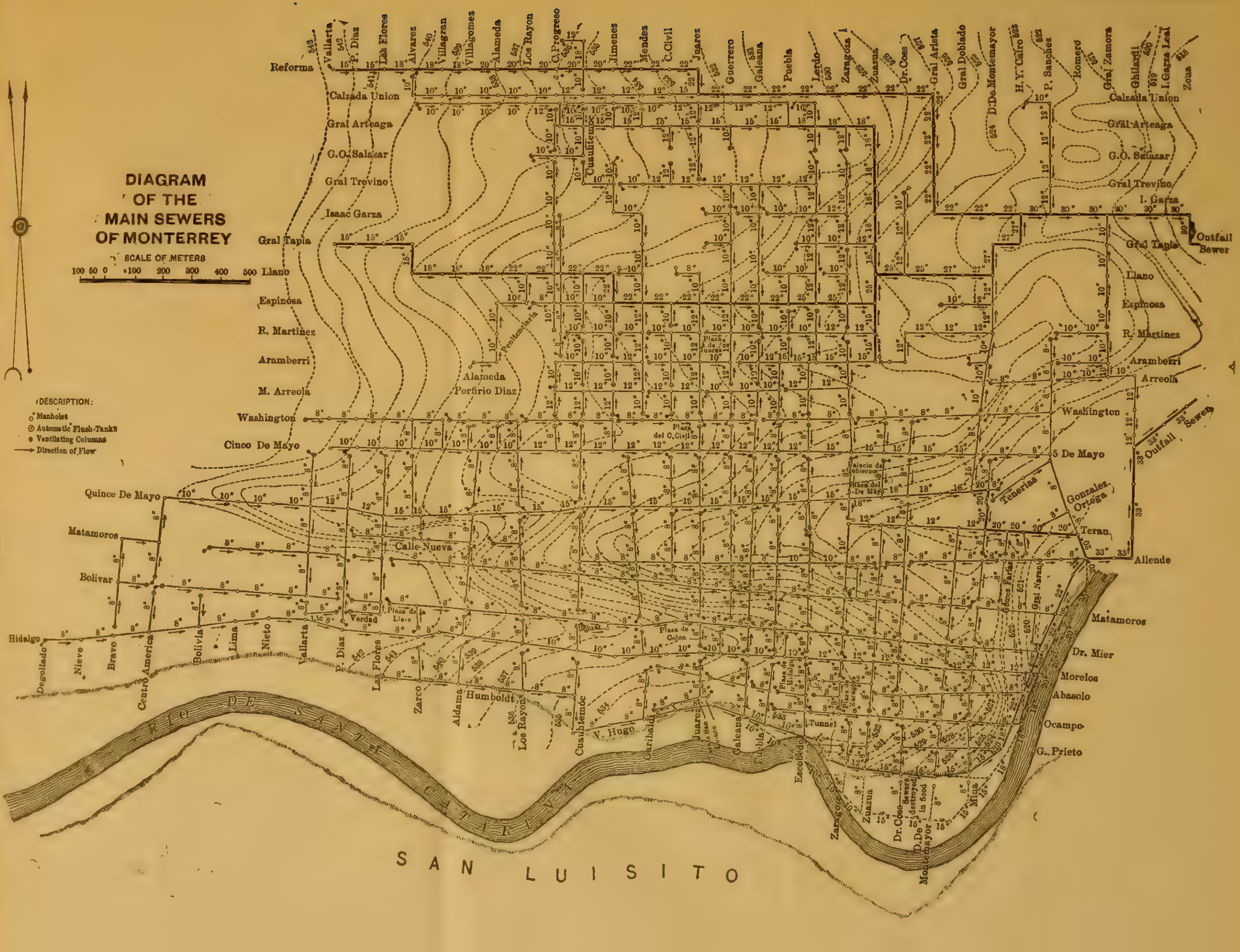


DIAGRAM OF THE MAIN SEWERS OF MONTERREY

SCALE OF METERS
100 50 0 100 200 300 400 500

DESCRIPTION:
- ○ Manholes
- ⊙ Automatic Flush-Tanks
- ● Ventilating Columns
- → Direction of Flow

and there had been very little evaporation during the intervening dry spell.

The writer has calculated that at Monterrey this flood reached the enormous quantity of 6 650 cu. m. (235 000 cu. ft.) per sec., a rate equal to 432 cu. ft. per sec. per sq. mile of water-shed.* The effect of this flood was to demolish completely about 1 200 "sillar" houses (without taking into consideration the numerous wooden houses) at Monterrey, and to cause a fearful loss of life, variously estimated between 3 000 and 5 000 persons; the lower figure the writer believes is approximately correct. At San Geronimo the original pumping station was carried away entirely, leaving practically no trace whatever.

Shaft No. 2 was apparently destroyed, while No. 3 was turned at an angle of about 50° down stream and filled up completely with sand. The infiltration gallery, near Shaft No. 2, was completely blocked with fine sand and gravel, and access could only be obtained as far as 54 m. The profile, Plate CLXXXIX, shows the change which had taken place in the river bed. The original course of the stream was changed to the north bank, 50 m. distant, the effect of the scouring action of the flood being to lower the general level at this point about 3.65 m., while the southern portion of the channel was slightly raised. At present (April, 1910), the end of the driven portion of the infiltration gallery is about 35 m. from the center of the stream, which is still carrying about 2 270 liters (80 cu. ft.) per sec.

Immediately after the flood the flow in the gallery was 450 liters (16 cu. ft.) per sec., and this quantity has remained constant since that time. The probable effect of the flood was to disturb the whole subsurface above the infiltration gallery and put it in motion, completely cleaning the gravels of their surrounding clay, which would account for the large infiltration of water in so limited a distance. The water has always been limpid and pure, but its hardness remains the same as it was prior to the flood.

With the copious supply of water from this source, due of course to abnormal conditions and not likely to be permanent, the operations of tunneling have been suspended temporarily; but it is proposed to continue the driving of the gallery, from a new shaft west of No. 3. The water encountered will be drained off by pumping until the main water-bearing gravels, in the neighborhood of Shaft No. 5, are reached. It is also proposed to reconstruct the 30-cm. high-level pipe line, from San Geronimo along the high road on the north bank of the river, so that by pumping water can be delivered to the city system from Shafts Nos. 5, 6, and 7, in the event of a shortness of supply from the Estanzuela River.

---

* The writer, in a brief article contributed to *Engineering News* soon after the flood (September 23d, 1909), gave this figure as 271 500, or approximately equal to a run-off of 500 cu. ft. per sec. per sq. mile; but, from a later and more complete study of the conditions for many miles above Monterrey, he believes the above quantity to be approximately correct.

Shaft No. 1.—Shaft No. 1 is designed to connect the infiltration gallery with the gravitation tunnel. This shaft has an inner diameter of 2.43 m. (8 ft.) and is fitted with a special gate-valve. In the bottom of the door of this valve there is a smaller valve, 30 cm. in diameter, so that, when the infiltration gallery is closed for cleaning out the sump, the smaller door, which is operated through the same spindle by a bevel-geared head-stock at the top of the shaft, can be opened first. Space is also left for screens if these should be found necessary. Access to this shaft is gained by a reinforced concrete stairway in nine stages. The superstructure is to be supported on reinforced concrete column foundations carried to the firm rock, owing to the loose condition of the strata at the top of the shaft.

Aqueduct.—The construction of the concrete conduit was begun in April, 1908. Fig. 13 shows the general types. Type *A* was adopted in gravel and conglomerate formation, and Type *B* where the excavation was in "sillar," the soft nature of this rock permitting it to be excavated exactly to the required external diameter of the concrete lining.

The concrete which was without steel reinforcement was a 1: 2½: 3½ mixture, the sand being from the crusher and the aggregate from the river bed, screened to pass a 25-mm. mesh. Where the conduit crossed the river obliquely, immediately below the gravitation tunnel, it was strengthened with mass boulder concrete of Type *C*. During the great flood this heavy section withstood its effects without damage of any kind, but beyond this point, where the conduit had been laid in compact cemented gravels, the scouring action of the flood on the north bank lowered the level of the gravels from 2 to 3 m.; the only damage, however, was the scouring away of the gravels at the south side of the conduit. To prevent such an occurrence in the future, the conduit at that point was strengthened with additional concrete for a distance of

PLATE CXCIX.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.

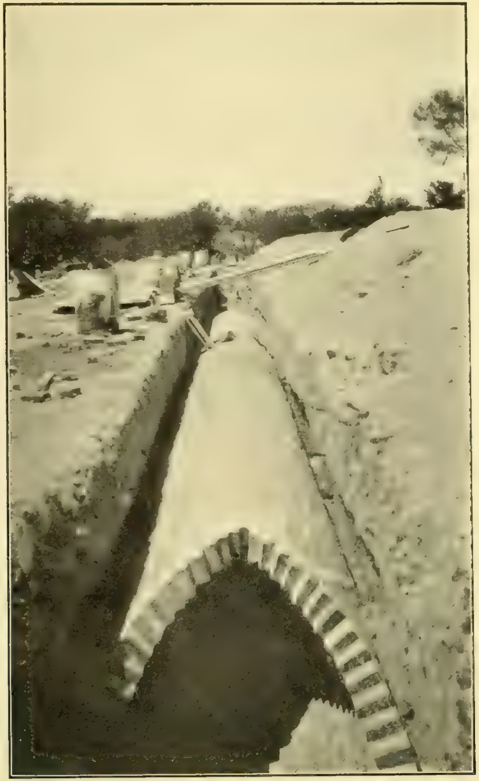


FIG. 1.—VIEW OF ARCH, OUTFALL SEWER.

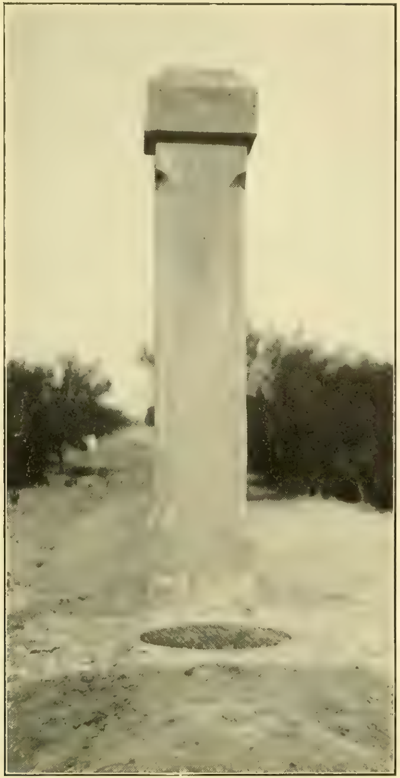


FIG. 2.—VENTILATING COLUMN AND MANHOLE,

195 m., as shown on Fig. 13. The extra concrete, amounting to 733 cu. m., was a 1: 3: 5 mixture, in which was embedded 20% of heavy boulders. The top of this special length now forms a weir for the present river flow. Where the conduit enters the bluff on the north side of the river, at 1 200 m., there is an overflow chamber which has a sluice-gate 76 cm. wide, arranged so that the conduit can overflow at the present time when running 76 cm. deep. To deflect the flow in the conduit, a wrought-iron plate, provided with a balance weight, is dropped into a groove on the lower side. The outlet is a 61-cm. concrete tube, having its invert above ordinary flood level, and arranged to be closed by a gate.

At 1 963 m. the conduit is carried over an arroyo on a segmental arch of 8 m. clear span, as shown on Fig. 13. There are 5 ventilating columns and 5 manholes on the aqueduct.

The aqueduct terminates in the Obispado distributing reservoir valve-house, at a level of 558.50 m. The work in connection with this aqueduct was completed by December, 1908.

Distributing Reservoir at Obispado.

The main distributing reservoir for the San Geronimo gravity supply is immediately below the historic Obispado (Bishop's Palace), at the western limits of the city. The general arrangement and lay-out is shown on Plate CXCI.

Valve-House.—The invert of the conduit from San Geronimo, where it enters the valve-house, is 558.50 m. above datum. The valve-house, which is built in the center of the reservoir, is shown on Fig. 2, Plate CXCVI. One of its special features is the provision of the main overflow at this point instead of within the reservoir proper. The inlet, main supply tunnel, independent by-pass overflow, scour-out pipes, gate-valves, and screens, are all controlled within the valve-house.

Reservoir.—The reservoir is rectangular, 126 by 81 m. (413.28 by 265.68 ft.) at the top, and has a water depth of 4 m. (13.1 ft.). In the design it was necessary to limit it to the lowest economical depth, so as to increase the static pressure over the low-pressure district as much as possible.

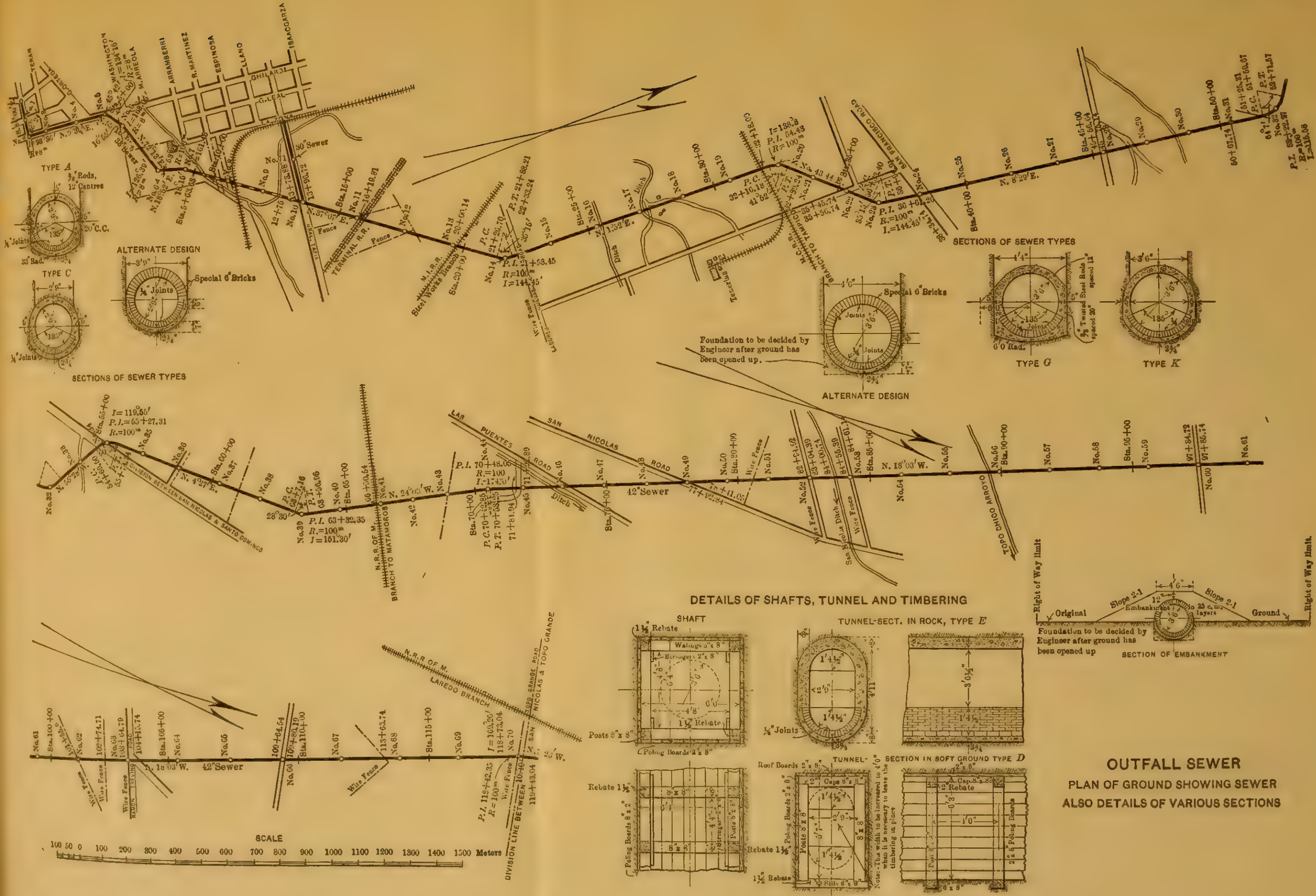
Excavation and Embankment.—The excavation, except for a depth of about 1 m. which was in black soil, was chiefly in a disintegrated "sillar" stratum of a heavy clayey nature, the greater part of which could be handled conveniently with plows and scrapers; the actual foundation on the eastern half required blasting for the final depths.

The total excavation amounted to 56 479 cu. m., of which 7 255 cu. m. were placed in the embankment, the remainder being deposited in the immediate neighborhood of the reservoir. The final trimming of the banks, which were left 30 cm. full, was not undertaken until the lining was begun. The work was done under contract with Mr. J. S. Nickerson, of Monterrey. The excavation had only one classification, and the contract prices were 0.50 peso per cu. m. for material carried to spoil banks, and 1.00 peso for material placed in the embankment. The excavation was begun in December, 1907, and completed in April, 1908. The work was then left standing until the end of 1908 to allow the banks to consolidate thoroughly prior to lining, which was begun on January 4th, 1909.

Concrete Lining and Roof.—Plate CXCI shows the general plan and sections, the main feature being the simple division of the reservoir into 24 rows of columns longitudinally and 15 rows transversely, making a total of 360 columns, less the four left out at the central tower. All the columns are 5 m. apart both ways. The roof was designed for a live load of 100 lb. and a dead load of 150 lb., the same as at the South Reservoir. With the exception of the floor, all the concrete work was reinforced with twisted steel lug bars. The foundation load on the columns for the eastern half of the reservoir is 9 tons per sq. ft.; that on the columns for the western half, where the foundation is of very hard sillar and conglomerate, is 1.95 tons per sq. ft.

Underdrainage of the Floor.—To provide for proper drainage in case of seepage, the floor was underdrained with rubble drains, 30 cm. wide and 23 cm. deep, filled with large round gravel carted from the bed of the Santa Catarina River. The total length of these underdrains is 1 160 m. In order to facilitate the detection of any seepage, they were conducted to a permanent inspection pit outside of the reservoir.

Main Distributing Conduit.—The main distributing conduit is laid along the inside of the reservoir, at the inlet end, and carried on elliptical arches of 2 m. span to a height of 71 cm. above the finished floor level. This conduit is 76 cm. high and 45.7 cm. wide, and it branches in two directions from the inlet tunnel to each side of the


TYPE A
⅜" Rods, 12" Centres
20" C.C.
½" Joints
33' Rad.
ALTERNATE DESIGN
Special 6" Bricks
¼" Joints
TYPE C
SECTIONS OF SEWER TYPES
30" Sewer
Steel Works Branch
TERMINAL R.R.
M.I.R.R.
Fence
Ditch
Wire Fence
N.C.R.R. BRANCH TO TAMPICO
SAN FRANCISCO ROAD
Special 6" Bricks
Foundation to be decided by Engineer after ground has been opened up.
ALTERNATE DESIGN
SECTIONS OF SEWER TYPES
TYPE G
TYPE K
¾" Twisted Steel Rods spaced 12"
DIVISION BETWEEN SAN NICOLAS & SANTO DOMINGO
N.R.R. OF M. BRANCH TO MATAMOROS
LAS PUENTES ROAD
SAN NICOLAS ROAD
42" Sewer
TOPO CHICO ARROYO
N. 18° 03' W.
DETAILS OF SHAFTS, TUNNEL AND TIMBERING
SHAFT
Walings 8"x 8"
Stringers 2"x 8"
Posts 8"x 8"
Poling Boards 2"x 8"
Rebate 1½"
TUNNEL-SECT. IN ROCK, TYPE E
¼" Joints
TUNNEL-SECTION IN SOFT GROUND TYPE D
Roof Boards 2"x 8"
Caps 8"x 8"
Sills 6"x 8"
Note: The width to be increased to 4'0" when it is necessary to leave the timbering in place
Right of Way limit
Original Ground
Slope 2-1
Embankment in 25 c.m. layers
Foundation to be decided by Engineer after ground has been opened up
SECTION OF EMBANKMENT
N.R.R. OF M. LAREDO BRANCH
TOPO GRANDE ROAD
SAN NICOLAS & TOPO GRANDE
DIVISION LINE BETWEEN
SCALE
100 50 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 Meters

OUTFALL SEWER
PLAN OF GROUND SHOWING SEWER
ALSO DETAILS OF VARIOUS SECTIONS

reservoir, its total length being 69 m. In order to prevent any stagnation and to give a continuous circulation, the water is delivered at eight points, in the length of the distributing pipe, through square openings with semicircular tops, the areas of the openings increasing toward the ends. These inlets are placed so that the current will not strike the roof columns.

Outlet Tunnel and Valve-House.—The outlet tunnel is at the north end of the reservoir, and was excavated in hard sillar rock. The tunnel is lined with concrete 30 cm. thick, the finished internal dimensions being 1.52 by 0.91 m. The length of the tunnel is 22.5 m. to the point where it enters the outlet-house. This house is divided by a wall 45 cm. thick, which supports a 76-cm. (30-in.) penstock-valve. The supply pipe to the city leaves this chamber in the west wall, and is also fitted with a 76-cm. penstock-valve. The supply pipe has a copper screen of the same design and dimensions as those in the inlet-house. A 30-cm. (12-in.) scour-out pipe in this chamber provides for draining the contents of the reservoir to a neighboring irrigation ditch, when necessary.

The superstructure of the valve-house is of concrete, and at the floor level there are bevel-geared head-stocks to raise the valves, etc.

By-Pass and Supply Pipes.—The by-pass and supply pipes are carried below the reservoir embankment to join the main 76-cm. (30-in.) cast-iron distributing pipe to the city. For this short distance they were constructed of concrete, 76 cm. in internal diameter, 10 cm. (4 in.) thick, reinforced with 6½-mm. square steel longitudinal rods, 30 cm. from center to center in the circumference, and hooped with 6½-mm. square steel rods spaced 30 cm. apart. The concrete forming these pipes was a 1: 1½: 2½ mixture.

Parapet Walls.—The parapet walls have 12 piers at each side and 8 at each end. In these piers there are ventilating openings branching at the top to each side of the parapet, with outlets provided with cast-iron screens. This arrangement gives 4 sq. m. of ventilating space (exclusive of that provided in the central tower), equally distributed at 40 points around the walls of the reservoir.

General Construction Scheme.—The concrete mixing plant, which consisted of two No. 1 Smith mixers, was arranged in connection with the bins and hoppers for the rock and sand on the high ground to the west, and from there the material was conveyed on a framed timber gangway carried right across the center of the reservoir, as shown by Fig. 1, Plate CXCV. From this central platform the concrete for the columns was filled from stages placed on the top of traveling towers, 5 m. high, which were run between two rows of columns on standard-gauge rails laid on the floor of the reservoir. By this arrangement 24 columns could be filled from each length of track. A main narrow track was also laid right around the reservoir, with the necessary turn-outs.

The forms for the columns, primary and secondary beams, are shown on Plate CXCII. The side forms for the primary beams were struck in 24 hours, so as to economize lumber; but the bottom lumber was left in position for 28 days. To avoid much unnecessary timber, the secondary beam forms were supported at the ends on reinforced concrete corbels cast on the primary beams.

For placing the side-walls, a special traveling form was used, the details of which are shown clearly on Plate CXCII. At the end of each form an expansion joint of 25 cm. was left to be filled after the roof was placed in position. The concrete was delivered to the wall through stove-pipe chutes, and carefully spaded by workmen in the limited space between the forms and the embankment. The wall form was removed after 36 hours, by loosening the jacks and pulling forward the hooked tie-rods. This form is also shown on Fig 2, Plate CXCIV.

The concreting of the roof slab was carried on continuously, and, when partly completed, the floor was laid in the shade. The bottom layer of the floor, 13 cm. thick, was laid in continuous panels between the columns, and brought to a fairly smooth surface. On this surface, after keeping it wet for 10 days and then allowing it to dry thoroughly, a layer of asphaltum, supplied by the American Asphaltum and Rubber Company, of Chicago, was placed. The work was done by ordinary Mexican laborers after they had received a few days' instruction from one of the Asphaltum Company's superintendents. The surface of the lower layer was kept perfectly clean, and then received one coat of "Pioneer" paint. The asphaltum, heated in a boiler inside the reservoir to a temperature of approximately 425° Fahr., was then poured over the floor from buckets, in a layer approximately 4 mm. thick. Where the floor joined the column pedestals, and at each new panel section, a double thickness was used. The labor cost of water-proofing, including superintendence, etc., amounted to

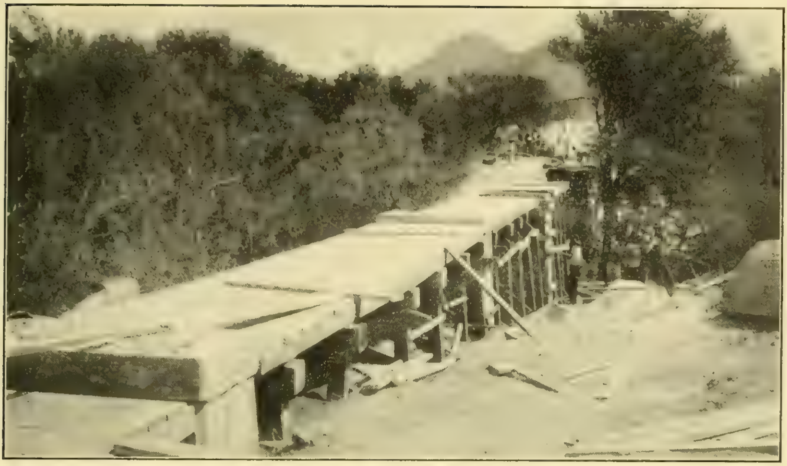


FIG. 1.—FORMS FOR MAIN GIRDERS, ESTANSCIA BRIDGE, OUTFALL SEWER.

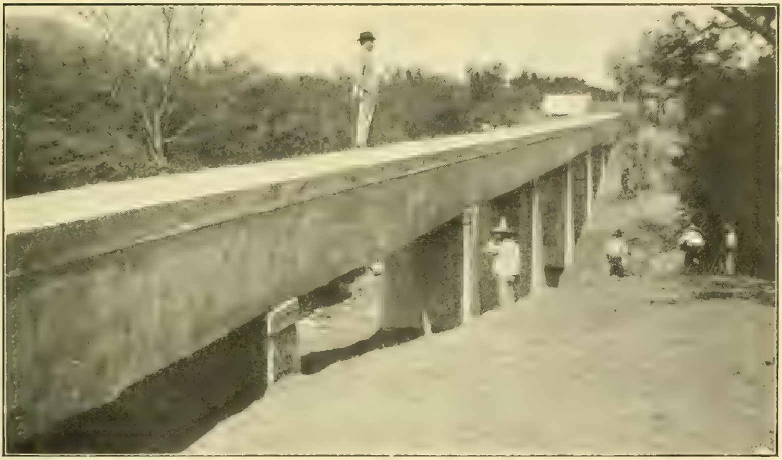


FIG. 2.—VIEW OF ESTANSCIA BRIDGE, COMPLETED.

3.3 cents (Mexican) per sq. m. for painting with "Pioneer" paint, and 5.4 cents for the asphaltum coating, or a total labor cost of 8.7 cents per sq. m. for the complete water-proofing. This cost is based on a rate of 8.00 pesos per day for a foreman, and 1.00 peso for each laborer. It required 50 U. S. gal. of the paint to cover 265.2 sq. m., and an average of about 6 lb. of asphaltum for 1 sq. m.

The upper concrete layer of the floor, 10 cm. thick, was placed so as to break joint with the lower, and was brought to a smooth surface with wooden floats sheathed with steel and reaching across the panels. In this way a perfectly smooth surface was obtained without any plastering.

The concrete for the beams, columns, side-walls, and floor, was a 1: 2½: 4 mixture, crushed sand and stone being used throughout. In the roof slab the mixture was 1: 2: 3.

The whole of the concrete work of the reservoir was completed in 6 months, by the Company's own administration, and the reservoir was first put into service a few days after the great flood of August 27th, when the Estanzuela supply main, crossing the Santa Catarina River, was partly destroyed. Since that time frequent examinations of the inspection pit, which is connected by a pipe to the rubble drains under the floor, have never revealed the slightest leakage.

Lay-Out of the Reservoir Roof and Grounds.—The Company owns about 11½ hectares of land, which includes that occupied by the reservoir and its surroundings, and as this property is in an attractive situation, commanding fine views of the Sierra Madre Mountains, the whole of the works have been given a pleasing architectural character, and the grounds laid out to form a public park for the citizens of Monterrey.

The general plan of the scheme is shown by Fig. 14 and Fig. 2, Plate CXCVI. The roof, which has an area of 1 hectare, has been laid out with walks and grass plots, and the surrounding embankments have been converted into driveways. Above the reservoir a small plazuela of ½ hectare has been laid out with a space above it for a band stand. The whole of the ground has been encircled with carriage drives, on which it is the intention to plant shade trees. The lay-out of this land also embraced the scheme for protecting the reservoir by draining the surface-water away to the irrigation ditches.

Comparison of South and Obispado Reservoirs.

The two reservoirs are practically of the same capacity, the only difference being the level of the overflows in their relationship to the roof, which gives the Obispado Reservoir a slightly greater capacity. Some comparative figures may be of interest, owing to the differences in type and construction. Table 7 gives the comparative quantities of material in each reservoir proper, that is to say, exclusive of the valve-houses, lay-out of grounds, etc.

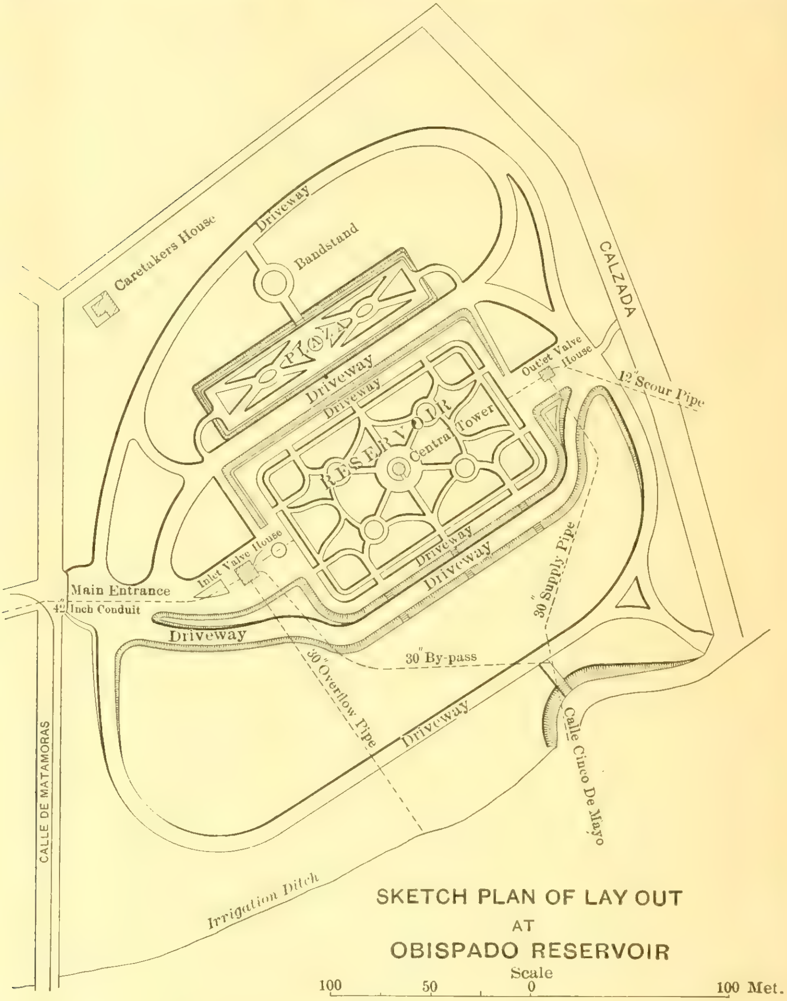
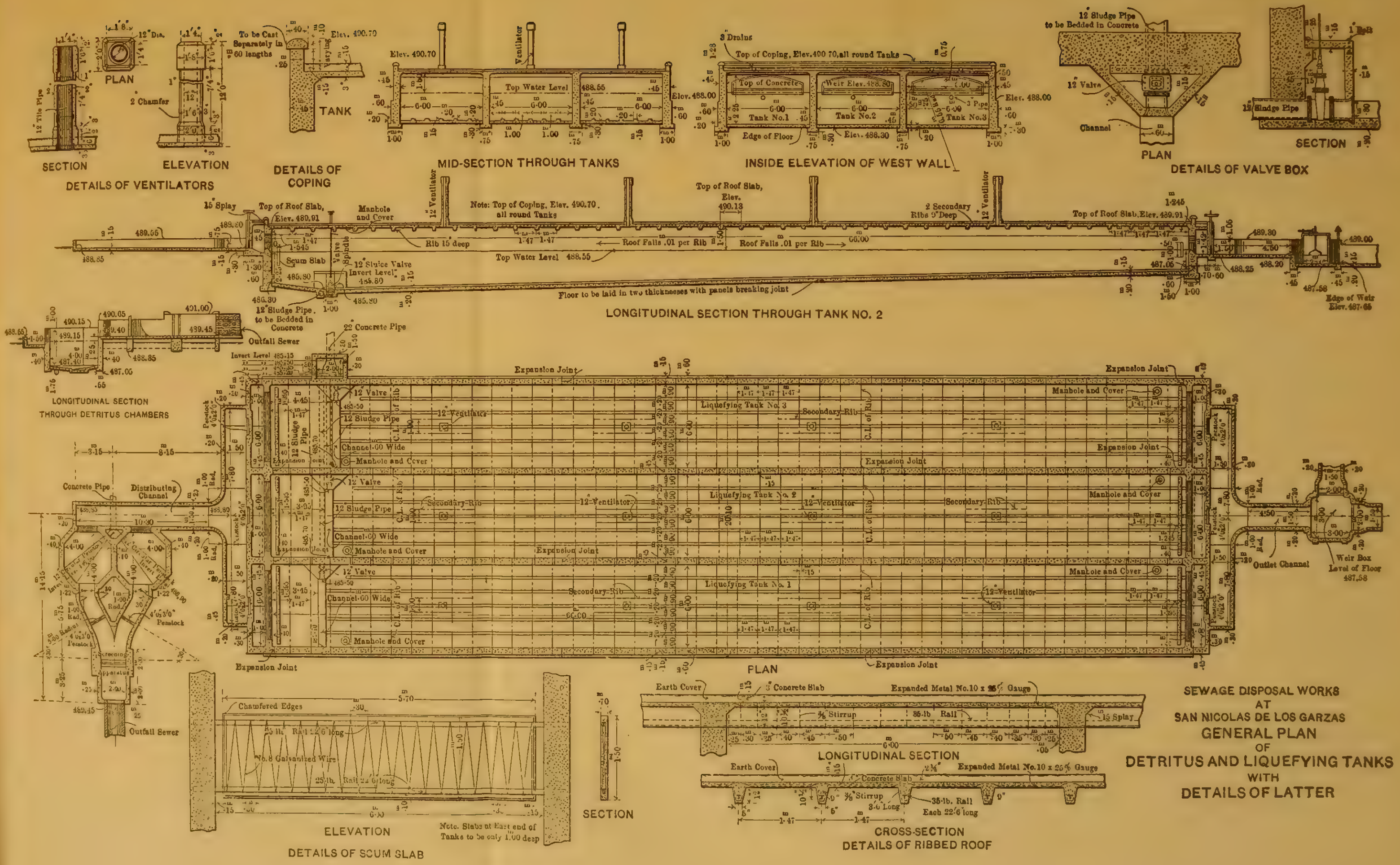


Fig. 14.

PLATE CCII.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.



SECTION

ELEVATION

DETAILS OF VENTILATORS

PLAN

DETAILS OF COPING

MID-SECTION THROUGH TANKS

INSIDE ELEVATION OF WEST WALL

PLAN

SECTION

DETAILS OF VALVE BOX

LONGITUDINAL SECTION THROUGH TANK NO. 2

LONGITUDINAL SECTION THROUGH DETRITUS CHAMBERS

PLAN

ELEVATION

SECTION

DETAILS OF SCUM SLAB

LONGITUDINAL SECTION

CROSS-SECTION

DETAILS OF RIBBED ROOF

SEWAGE DISPOSAL WORKS
AT
SAN NICOLAS DE LOS GARZAS
GENERAL PLAN
OF
DETRITUS AND LIQUEFYING TANKS
WITH
DETAILS OF LATTER

TABLE 7.—Comparison of Materials in South and Obispado Reservoirs.

	South Reservoir.		Obispado Reservoir.	
	No.	Quantities, in cubic meters.	No.	Quantities, in cubic meters.
Earthwork:				
Total excavation	......	34 000	......	56 479
Placed in embankment	......	31 500	......	7 255
Placed in spoil banks	......	2 500	......	49 224
Concrete:				
Columns (including foundations)	135	1 240	356	543
Primary beams	135	440	374	462
Secondary beams	670	515	1 252	576
Side-walls	......	1 255	......	710
	Square meters.		Square meters.	
Roof slab	5 140	520	10 206	1 020
Floor	4 070	780	9 200	2 120
Parapet walls	......	90	......	165
Total concrete	......	4 840	......	5 596
		Pounds.		Pounds.
Reinforcing steel bars	......	387 000	......	380 000
		Square meters.		Square meters.
Expanded metal in roofs, slabs, etc	......	5 691	......	10 490

The total cost of these reservoirs, including valve-houses, by-passes, and the length of supply pipe where the by-pass joins, and including all engineering expenses, etc., but exclusive of the cost of lands, planting, fencing, and special work in connection with the formation of parks, was as follows:

South Reservoir: 394 000 pesos, or 10 368 pesos* per million liters.

Obispado Reservoir: 375 000 pesos, or 9 375 pesos* per million liters.

These rates may be regarded as reasonable when taking into consideration the special difficulties of construction in Mexico, and the high cost of all imported material, on which heavy duties are levied.

The value of the materials alone in these reservoirs amounted to more than 70% of their total cost.

---

* Mexican currency.

ANALYSES OF ESTANZUELA AND SAN GERONIMO WATERS.

Table 8 shows analyses of the Estanzuela and San Geronimo waters, made in February, 1910, by Messrs. Ledoux, of New York City. The Estanzuela sample was taken at the valve-house of the South Reservoir, while that of San Geronimo was taken in Shaft No. 1 of the infiltration gallery when flowing at the rate of about 450 liters per sec. Both waters are absolutely free from turbidity.

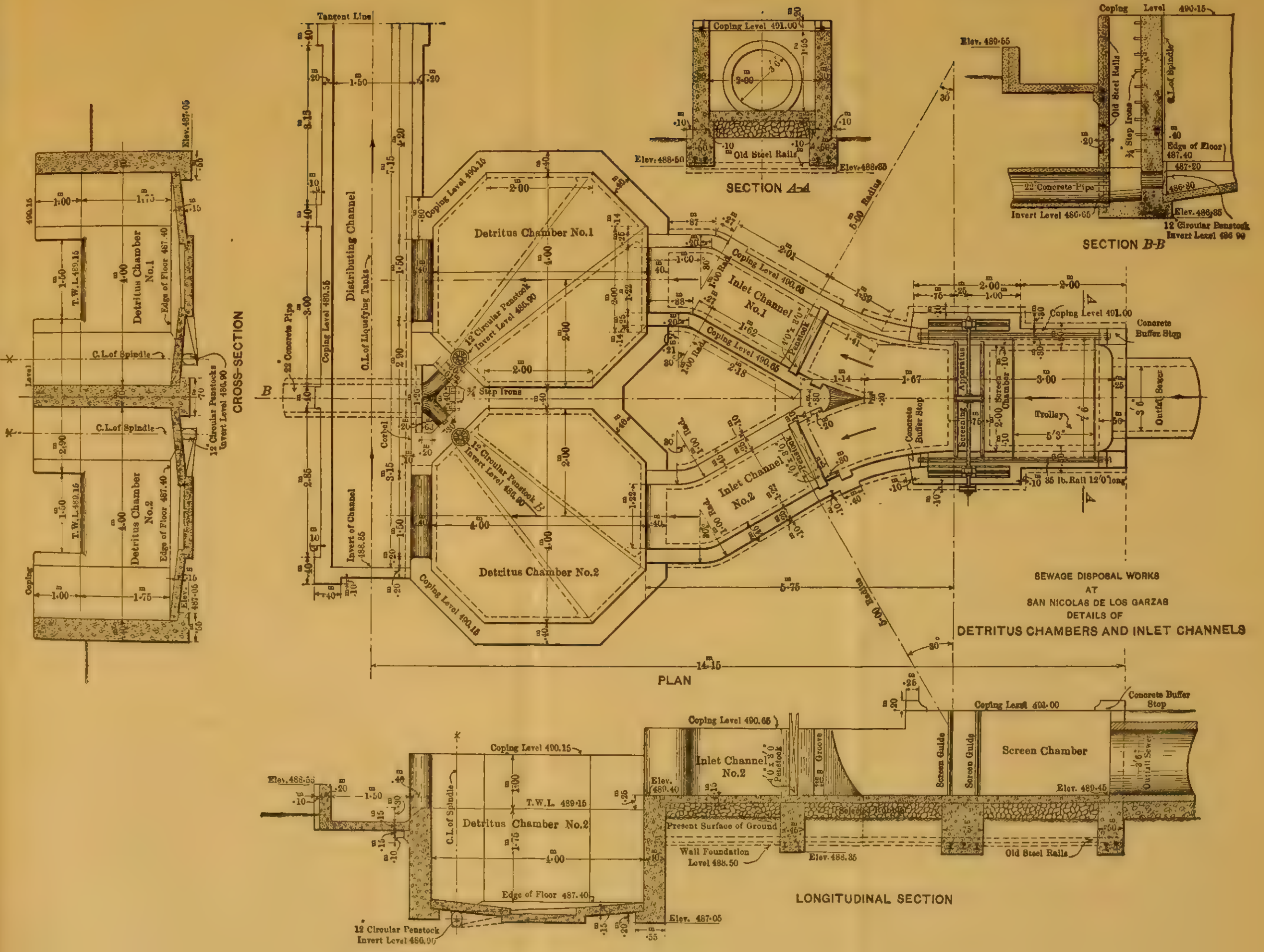
TABLE 8.—ANALYSES OF ESTANZUELA AND SAN GERONIMO WATERS.
In Parts per Million.

	Estanzuela.	San Geronimo Infiltration Gallery.
Total solid matter in solution	209.00	305.00
Organic and volatile matter	Not weighable.	Not weighable.
ANALYSIS OF SOLIDS:		
Silica	10.5	12.0
Iron and Alumina	Traces.	Traces.
Lime	85.4	112.6
Magnesia	3.8	22.6
Soda (Na_2O)	13.3	20.2
Potash (K_2O)	2.0	1.9
Sulphuric Acid	24.4	41.5
Chlorine	2.0	2.8
PROBABLE COMBINATION OF BASES AND ACID RADICALS IN THE SOLIDS:		
Silica	10.5	12.0
Iron and Alumina	Traces.	Traces.
Sodium Chloride	3.3	4.6
Potassium Sulphate	3.7	3.5
Sodium Sulphate	26.3	40.8
Calcium Sulphate	13.3	22.1
Calcium Carbonate	142.7	184.8
Magnesium Carbonate	8.4	49.8
	208.2	317.6
Nitrogen as Free Ammonia	0.004	0.032
Nitrogen as Albuminoid Ammonia	0.006	0.022
Nitrogen as Nitrites (N_2O_3)	0.002	0.002
Nitrogen as Nitrates (N_2O_5)	0.100	1.85
Total Hardness (as $CaCO_3$)	155.0	220.0
Alkalinity (as $CaCO_3$)	121.0	180.0

CITY WATER DISTRIBUTION SYSTEM.

The distribution system was begun in September, 1906, but the general lay-out of the mains was modified in July, 1907, in view of the division of the system into two services, for high and low pressure. Plate CXCVII shows in skeleton form the lines of the cast-iron mains. These are laid at the present time along routes containing

PLATE CCIII.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.



SEWAGE DISPOSAL WORKS
AT
SAN NICOLAS DE LOS GARZAS
DETAILS OF
DETRITUS CHAMBERS AND INLET CHANNELS

houses (excluding wooden shacks) which can be served immediately. The distribution system is arranged to serve as follows:

Estanzuela supply	4 150 houses.
San Geronimo supply	8 600 "
Total	12 750 houses.

This represents, at the present time, a division of the city of 32½% for the Estanzuela, and 67½% for the San Geronimo supply. Of the area of the supply district north of Santa Catarina River, 57% will be supplied from San Geronimo and 43% from Estanzuela. The real development of the city, however, is northward in the area of the low-pressure supply.

The static pressure over the city in the two sections varies as follows:

Estanzuela supply	85 to 50 lb.
San Geronimo supply	55 to 29 lb.

The main supply pipe from the South Reservoir is 61 cm. (24 in.) in internal diameter, and this size allows ample provision for future extensions. The supply pipe from the Obispado Reservoir is 76 cm. (30 in.) in internal diameter. On this main, in Calle de Cinco de Mayo, at a distance of 320 m. from the reservoir, has been placed a 76-cm. (30-in.) Venturi meter, the recording apparatus being in the house on the side of the road. Both these supply pipes are carried well into the city, and from them the distribution mains are laid; these are 45.7 and 30 cm. (18 and 12 in.) in internal diameter, with intermediate sections of 15 and 10 cm. (6 in. and 4 in.). Along Calle de Cinco de Mayo, where the division between the two services takes place, two lines are laid, a 30-cm. for high pressure and a 38-cm. (15-in.) for the low pressure. A duplicate pipe, 30 cm. (12 in.) in diameter, is also laid in Calle de Dr. Coss. On Calle de Alvarez the low-pressure pipe is 61 cm. (24 in.), and the high-pressure, 45.7 cm. (18 in.) in diameter. Provision is also made for extending the range of the two services to other districts. Practically every block is provided with gate-valves to cut off the supply in any direction. On the 76-cm. main, 61-cm. (24-in.) valves are used, and are connected by tapers to the pipe. On the 61-cm. mains, 45.7-cm. (18-in.) valves are used. The actual frictional loss by reducing the valve being small, this method permitted the use of valves of a more convenient size. On all the larger valves there are 15-cm. by-passes fitted with independent gate-valves.

Scour-out pipes, 10 cm. (4 in.) and 15 cm. (6 in.) in diameter, are placed in various parts of the system, draining to the sewers. Air-valves, both double and single, are also placed at high points in different parts of the system.

Reducing Valves.—At four points in the system the mains are arranged so that the supply can be interchangeable. Fig. 15 shows the arrangement of the mains at the junction of Cinco de Mayo and Alvarez Streets, and is typical of the arrangement at the other points.

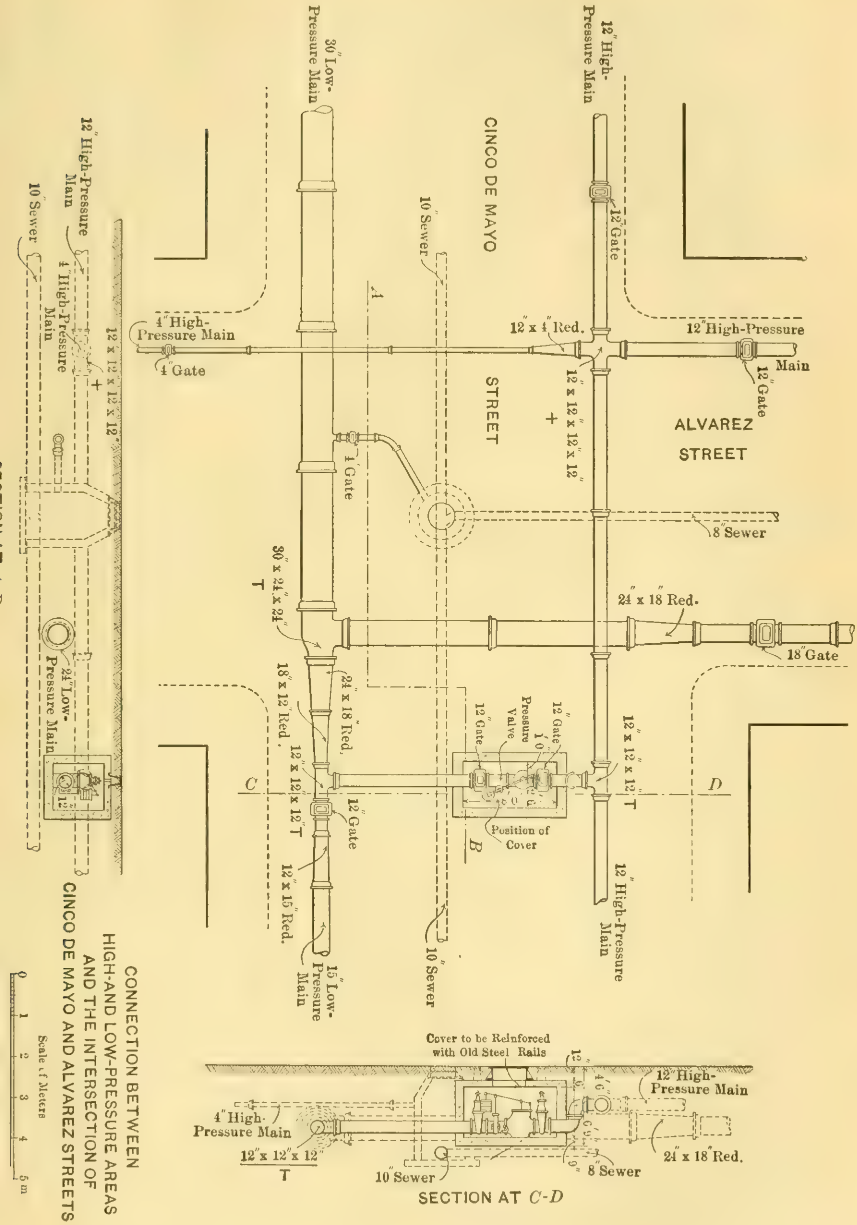
Each reducing valve is placed on a 30-cm. (12-in.) branch main between the two services. These valves adjust themselves automatically to the pressure required, after they have been properly regulated to the different pressures on either side. To allow repairs to be easily made, there are ordinary gate-valves at each end enclosed in the same pit. If necessary, as in case of fire, any part of the system can be changed into high pressure temporarily by closing the valves against the San Geronimo supply.

Table 9 gives the length of the mains as laid, and the number of valves.

TABLE 9.—LENGTH OF WATER MAINS.

DIAMETER:		Length, in meters.	Number of gate-valves.
Centimeters.	Inches.		
10.2	4	49 831.68	677
15.2	6	31 918.31	306
30.5	12	14 461.31	117
38.1	15	1 661.98	11
45.7	18	4 522.61	5
61.0	24	2 826.54	10
76.2	30	1 454.40	...
Totals......................		106 676.83	1 126

The pipes were all cast according to the British Standard Specification, in 3.65-m. (12-ft.) lengths, and were supplied by Messrs. D. Y. Stewart and Company, and Messrs. Dick, Kerr and Company, of Kilmarnock and London. The valves were all of standard design, faced with gun-metal, and were supplied by Messrs. Glenfield and Kennedy, Limited, of Kilmarnock, Scotland.



CONNECTION BETWEEN HIGH-AND LOW-PRESSURE AREAS AND THE INTERSECTION OF CINCO DE MAYO AND ALVAREZ STREETS

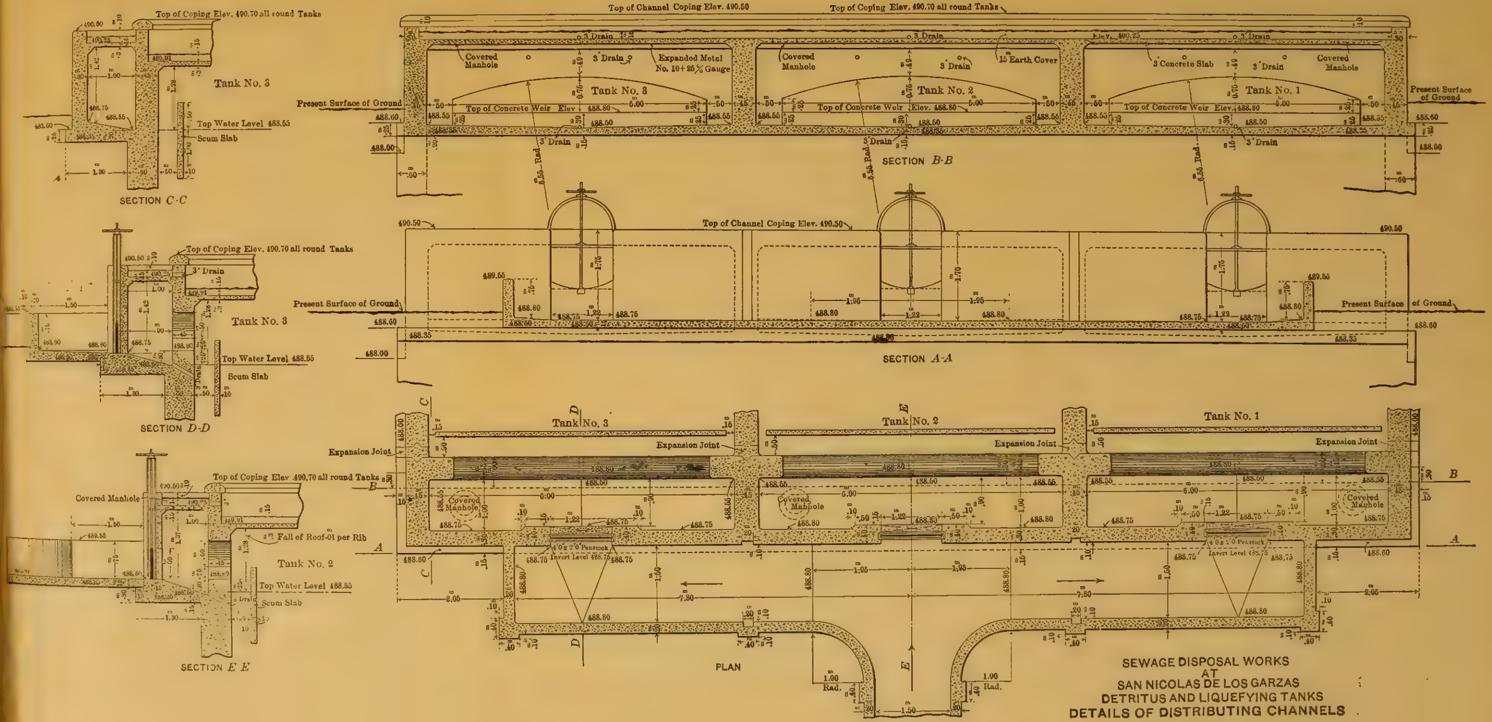
In the distribution system it is proposed to provide 200 fire-hydrants, by arrangement with the municipality, but only a few of these have been placed. The general type is a double hydrant for two 63.5-mm. (2½-in.) streams. These are to be placed at the corner of every block in the business portion of the city; single-way hydrants will be used in the residential districts.

Laying Cast-Iron Pipes.—Table 10 has been prepared to show what can be accomplished with Mexican labor in laying pipes. In this kind of work the labor was particularly efficient; after the gangs were once drilled into shape, the work proceeded systematically, and at very good speed. All the pipes, after being laid, were tested to 150 lb. per sq. in. in the presence of the Technical Inspector.

Table 11 gives the details of the excavation, the material, and the average cost, of laying about 106.6 km. of pipes.

House Connections.—The ordinary house connections, which are of 19-mm. (¾-in.) galvanized-steel pipe, are connected to the mains by lead goosenecks and brass corporation cocks. The Company's obligation under the concession extended to the edge of the sidewalk, and at this point curb-boxes, chiefly of the Hays pattern, were placed; but, subsequently, owing to the metering of every house service in the city, the control of the Company extended to the meter, which, as a rule, is placed immediately inside of the house. Owing to the rapid deterioration of the house service pipes in some districts of the northern part of the city, where the soil is formed of decaying organic matter, it has been decided to use lead pipe entirely from the main to the meter.

Damage Due to Floods.—During the night of August 27th, the main 61-cm. pipe, under the river bed of Santa Catarina, at the point where the main entered the city, was destroyed for a distance of 130 m., due to the scouring away of a whole block of city property. The Venturi meter register chart at the South Reservoir showed that the break occurred a few minutes before midnight. The location of this pipe is shown by Fig. 5; its broken end was in proximity to an old bridge pier. Fortunately, at the time of the flood, the Obispado Reservoir works were completed, and the whole city was supplied with water from San Geronimo within 48 hours. As only about 1 500 services had then been connected, this delay was not serious; in fact, in the lower part of the city, the water in the mains was sufficient until the San Geronimo supply could be connected. To make a temporary con-



SEWAGE DISPOSAL WORKS
AT
SAN NICOLAS DE LOS GARZAS
DETRITUS AND LIQUEFYING TANKS
DETAILS OF DISTRIBUTING CHANNELS.

TABLE 10.—COST OF LAYING AND JOINTING CAST-IRON PIPES, EXCLUDING LOWERING AND TESTING.

Employees.	Rate for 10-hour day. Pesos.	76 CM. (30 IN.)				61 CM. (24 IN.)				50 CM. (20 IN.)				45.7 CM. (18 IN.)			
		No. of men.	Total cost of labor. Pesos.	No. of pipes laid.	Cost per linear meter. Pesos.	No. of men.	Total cost of labor.	No. of pipes laid.	Cost per linear meter. Pesos.	No. of men.	Total cost of labor.	No. of pipes laid.	Cost per linear meter. Pesos.	No. of men.	Total cost of labor.	No. of pipes laid.	Cost per linear meter. Pesos.
Foreman	4.50	1	4.50	......	....	1	4.50	......	....	1	4.50	......	....	1	4.50	......	....
Caulkers	3.00	4	12.00	......	....	5	15.00	......	....	4	12.00	......	....	4	12.00	......	....
Lead pourers	2.00	2	4.00	......	....	2	4.00	......	....	2	4.00	......	....	2	4.00	......	....
Lead melter	1.50	1	1.50	20	0.498	1	1.50	25	0.410	1	1.50	35	0.287	1	1.50	40	0.221
Pipe cutter	2.00	1	2.00	......	....	1	2.00	......	....	1	2.00	......	....	1	2.00	......	....
Peons	1.00	12	12.00	......	....	10	10.00	......	....	12	12.00	......	....	8	8.00	......	....
Water boy	0.50	1	0.50	......	....	1	0.50	......	....	1	0.50	......	....	1	0.50	......	....
	....	22	36.50	......	....	21	37.50	......	....	22	36.50	......	....	18	32.50	......	....

Employees.	Rate for 10-hour day. Pesos.	38 CM. (15 IN.)				30.5 CM. (12 IN.)				15 CM. (6 IN.)				10 CM. (4 IN.)			
		No. of men.	Total cost of labor. Pesos.	No. of pipes laid.	Cost per linear meter. Pesos.	No. of men.	Total cost of labor.	No. of pipes laid.	Cost per linear meter. Pesos.	No. of men.	Total cost of labor.	No. of pipes laid.	Cost per linear meter. Pesos.	No. of men.	Total cost of labor.	No. of pipes laid.	Cost per linear meter. Pesos.
Foreman	4.50	1	4.50	......	....	1	4.50	......	....	1	4.50	......	....	1	4.50	......	....
Caulkers	3.00	4	12.00	......	....	4	12.00	......	....	4	12.00	......	....	4	12.00	......	....
Lead pourers	2.00	2	4.00	......	....	2	4.00	......	....	2	4.00	......	....	2	4.00	......	....
Lead melter	1.50	1	1.50	45	0.196	1	1.50	60	0.147	1	1.50	100	0.082	1	1.50	150	0.0574
Pipe cutter	2.00	1	2.00	......	....	1	2.00	......	....	1	2.00	......	....	1	2.00	......	....
Peons	1.00	8	8.00	......	....	8	8.00	......	....	6	6.00	......	....	6	6.00	......	....
Water boy	0.50	1	0.50	......	....	1	0.50	......	....	1	0.50	......	....	1	0.50	......	....
	....	18	32.50	......	....	18	32.50	......	....	16	30.50	......	....	16	30.50	......	....

TABLE 11.—CAST-IRON WATER PIPES.—COST OF MATERIALS AND LAYING AT MONTERREY.

MATERIALS PER STANDARD LENGTH OF PIPE.

DIAMETER OF PIPE:		Thickness, in millimeters.	Weight of pipe, in kilogrammes.	Cost per piece, f.o.b. Monterrey, in pesos.	LEAD:		OAKUM:	CHARCOAL:	Total cost of material per linear meter, in pesos.
Centimeters.	Inches.				Weight, in kilogrammes.	Cost, in pesos.	Cost, in pesos.	Cost, in pesos.	
10	4	10.3	109	11.65	2.0	0.37	0.025	0.0525	3.30
15	6	11.1	163	15.74	3.7	0.67	0.0675	0.065	4.51
30.5	12	15.8	463	76.50	7.9	1.44	0.1225	0.10	21.35
38	15	17.4	680	79.36	10.6	1.94	0.175	0.12	22.30
45.7	18	19.0	871	90.28	13.4	2.42	0.2375	0.1375	25.42
61	24	22.2	1 261	117.60	18.8	3.42	0.335	0.175	33.20
76	30	25.4	1 946	199.05	24.5	4.42	0.44	0.2125	55.77

LABOR.

DIAMETER OF PIPE:		Width of trench, in meters.	Depth. in meters.	Cubic meters per linear meter.	Cost of excavation per linear meter. Pesos.	Back-filling, and removing surplus. Pesos.	Total cost, excavation, back-filling, etc. Pesos.	HAULING PER LINEAR METER:		Cost of laying, per linear meter. Pesos.	Total hauling and laying, per linear meter. Pesos.	Total excavation and laying, labor, complete, per linear meter. Pesos.
Centimeters.	Inches.							Hauling. Pesos.	Miscellaneous. Pesos.			
10	4	0.55	0.90	0.50	0.60	0.18	0.78	0.0275	0.005	0.06	0.0925	0.8725
15	6	0.60	1.00	0.60	0.72	0.22	0.94	0.45	0.005	0.825	0.1325	1.0725
30.5	12	0.65	1.20	0.78	0.94	0.29	1.23	0.18	0.0075	0.1475	0.335	1.565
38	15	0.70	1.30	0.91	1.10	0.34	1.44	0.2725	0.01	0.19	0.4775	1.9125
45.7	18	0.80	1.40	1.12	1.34	0.41	1.75	0.2725	0.01	0.245	0.5275	2.2775
61	24	1.00	1.50	1.50	1.80	0.55	2.35	0.825	0.08	0.41	1.315	3.665
76	30	1.10	1.60	1.76	2.11	0.65	2.76	0.83	0.10	0.53	1.46	4.22

NOTE.—The above costs of earthwork are based on the following rates and percentages over the whole city:

Earth, per cubic meter	0.35 pesos	50%
Soft sillar	0.75 “	20%
Hard sillar	1.50 “	20%
Rock (chiefly conglomerate)	4.00 “	10%

SUMMARY OF TABLE 11.

DIAMETER OF PIPE:		Total labor cost, in pesos.	Materials. Pesos.	Total cost per linear meter, in pesos.
Centimeters.	Inches.			
10	4	0.8725	3.30	4.1725
15	6	1.0725	4.51	5.5825
30.5	12	1.565	21.35	22.915
38	15	1.9125	22.30	24.2125
45.7	18	2.2775	25.42	27.6975
61	24	3.665	33.20	36.865
76	30	4.22	55.77	59.99

PLATE CCV.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.

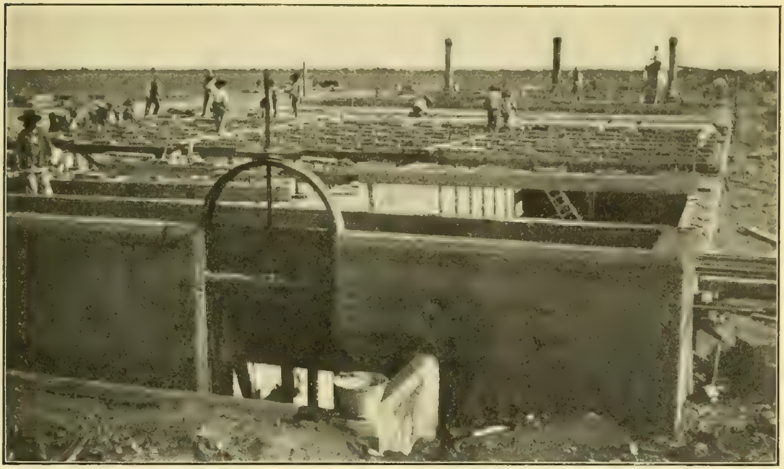


FIG. 1.—CAST CONCRETE BEAMS BEING PLACED IN POSITION, LIQUEFYING TANKS.

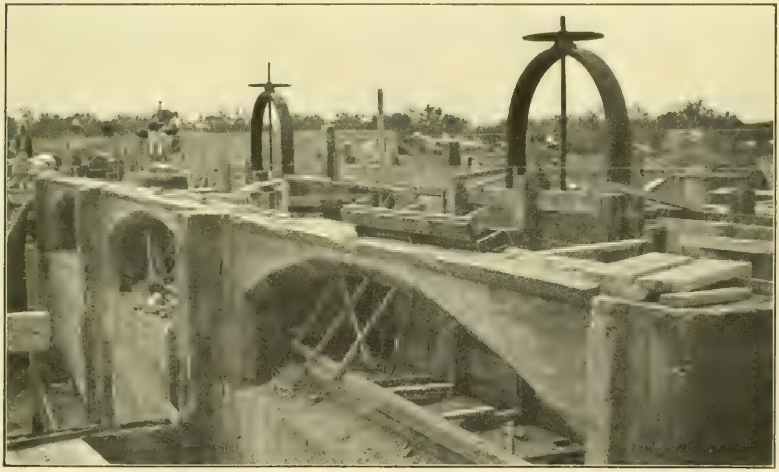


FIG. 2.—INLET WEIRS TO LIQUEFYING TANKS, DURING CONSTRUCTION.

nection to conduct the high-pressure water to the city, a 15-cm. steel pipe was placed above ground, on the line of the main, for a distance of 100 m. This pipe was supported by a cable 30 mm. in diameter and by timber trestles. By limiting the supply district, this pipe was of sufficient capacity to serve until the large main could be safely restored.

The flood destroyed about 1 200 houses in the neighborhood of the river. In a number of blocks the smaller mains were scoured away, but considerable salvage was done afterward, and, as it is the intention of the authorities not to permit rebuilding along the flood-path of the river, these mains do not require reconstruction.

MAIN SEWERAGE SYSTEM.

The Company's obligations, as far as drainage is concerned, were limited to the removal and disposal of sewage, no provision being required for storm-water, which is allowed to find its way to the natural watercourses. Apart from that fact, however, the best system for a city like Monterrey, where rainfall for many months at a time is very scarce, is the strictly "separate system." In the design advantage was taken of the natural topography of the drainage district, which is almost an ideal one for a gravitation system of sewers, the general fall in all directions being northeast; it was also in this direction that the best available land could be obtained for disposal purposes.

Plate CXCVIII shows in skeleton form the general lay-out of the sewers. Two drainage districts are arranged, divided by Calle de Washington, which may be regarded as practically the center of the city, and each of these districts has an independent main collector connecting to the outfall sewer at the northeast extremity of the city.

The system has been designed so that extensions may be made and may cover any part within the city limits; the main collectors are large enough for the whole area when fully built up.

The sewers are designed on a very liberal basis, namely, on the assumption that when flowing half full the quantity to be dealt with will be 380 liters per capita per day, with a maximum rate of flow of 200 per cent. It was assumed that each house would be occupied by 7 persons and have a frontage of 12½ m. The minimum velocities in the sewers when running full, vary between 0.91 and 1.5 m. per sec., with the exception of a few blocks.

The minimum size adopted was 24.3 cm. (8 in.) in internal diameter. The sewers of diameters between 24.3 and 50 cm., are 0.91 m. (36 in.) long, and are of salt-glazed vitrified clay, imported from San Antonio, Tex.

Table 12 gives the details of the length of the various sewers laid.

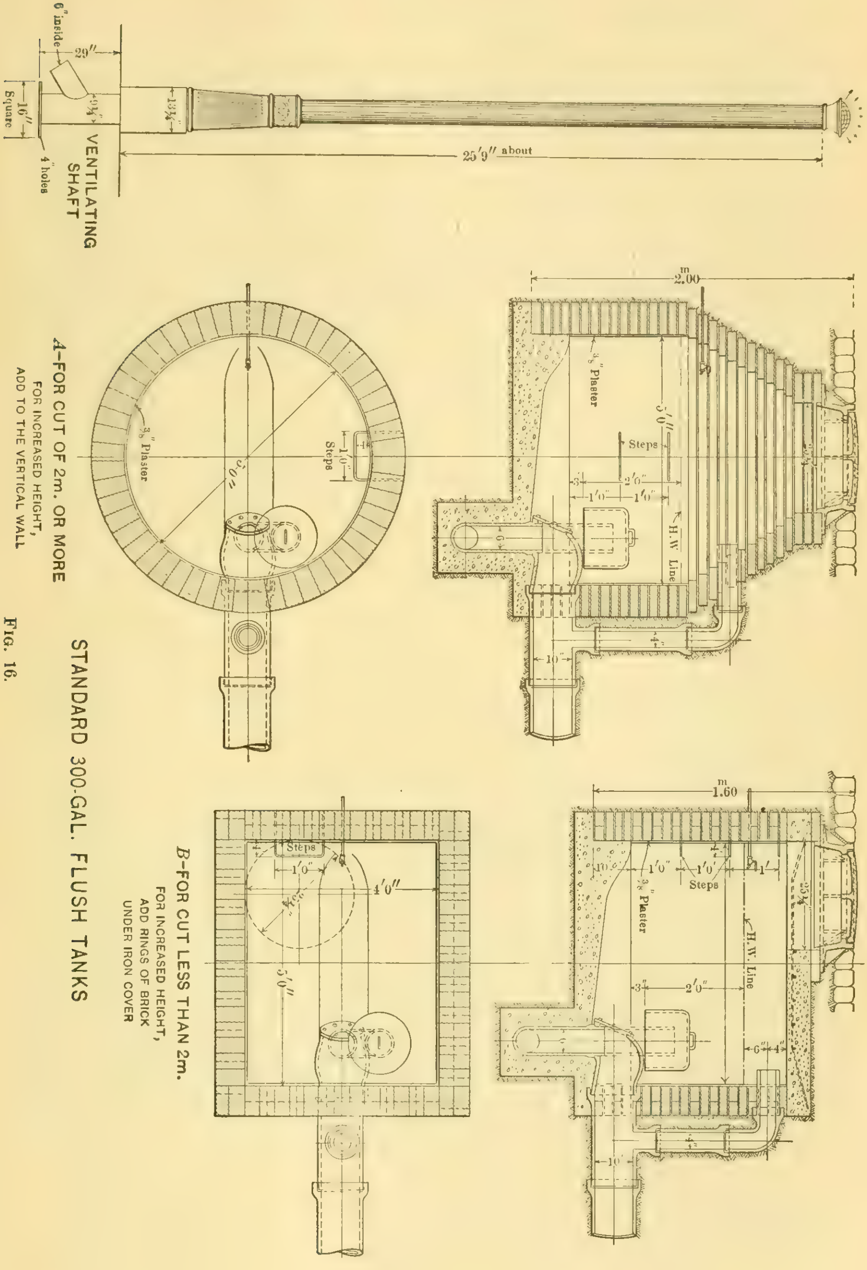
TABLE 12.—LENGTH OF SEWERS.

DIAMETER:		Kind.	Length, in meters.
Centimeters.	Inches.		
24.3	8	Fire-clay	38 332.85
25.4	10	“	16 400.69
30.5	12	“	7 953.15
38.1	15	“	4 850.56
45.7	18	“	2 023.40
50.8	20	“	1 450.53
55.9	22	Reinforced concrete tubes 6.9 cm. thick	3 134.20
61.0	25	“ “ “ 7.6 “ “	357.40
68.6	27	Brick and concrete	484.05
76.2	30	“ “ “	662.69
		Total..........	75 649.15

The greater number of the manholes are of brickwork, 23 cm. thick, and have concrete inverts. They have a diameter of 1.2 m., which is reduced to 0.61 m. at the top, and each is provided with a heavy cast-iron frame and closed cover weighing about 190 kg. There are 521 manholes, and they are placed at every block and on long lines about 80 m. apart.

The sewers are flushed with 15-cm. (6-in.) automatic flushing siphons of the Miller pattern with 20-cm. (8-in.) discharge pipes. There are 278 of these siphons, and they are placed in flush-tanks (Fig. 16) built of brickwork and plastered with 1:1 cement mortar. Their capacity varies from 800 to 1 200 liters, and they discharge from 22½ to 28½ liters per sec. They are timed to flush once in 24 hours.

The system is at present ventilated by 23-cm. (9-in.) steel ventilating columns (Fig. 16), with ornamental cast-iron bases. There are 220 of these columns. Most of them are 7.85 m. above the level of the edge of the sidewalk, and are connected to special 15-cm. branch pipes leading from the sewer on the outside of the flush-tanks. In the center of the city they are provided with extension lengths, giving a total height of 12 m.


VENTILATING SHAFT

A–FOR CUT OF 2m. OR MORE
FOR INCREASED HEIGHT,
ADD TO THE VERTICAL WALL

B–FOR CUT LESS THAN 2m.
FOR INCREASED HEIGHT,
ADD RINGS OF BRICK
UNDER IRON COVER

STANDARD 300-GAL. FLUSH TANKS

FIG. 16.

Table 13, gives the particulars of the average distributed cost of laying the 75.6 km. of sewers.

TABLE 13.—AVERAGE COST OF 75.6 KM. OF SEWERS PER LINEAR METER, FOR MATERIALS AND LABOR COMPLETE.

Kind of Sewer.	Internal Diameter of Sewers.		Cost of materials, including 10-cm. (4-in.) every 4½ m. Pesos.	Earthwork and Labor:			Total cost of sewer complete, per linear meter. Pesos.
	Centimeters.	Inches.		Average depth of sewer, in meters.	Cost of excavation, including back-filling, removing surplus, etc. Pesos.	Cost of labor in laying (including hauling, etc.) Pesos.	
Fire-clay..............	24.3	8	2.00	2.10	3.46	0.21	5.67
"	25.4	10	2.78	2.25	3.97	0.2625	7.0125
"	30.5	12	3.64	2.50	4.705	0.305	8.65
"	38.1	15	6.14	2.75	5.50	0.4375	12.0775
"	45.7	18	8.80	3.00	6.745	0.645	16.19
"	50.8	20	11.30	3.50	8.275	0.815	20.39
Concrete.............	55.9	22	5.93	3.50	9.19	1.325	16.445
"	61.0	25	7.30	3.75	11.245	1.685	20.23
One brick thick on concrete foundations.............	68.6	27	7.17	3.75	11.735	3.93	22.835
	76.2	30	7.925	4.00	14.53	4.515	26.97

The house connections are chiefly of 10-cm. (4-in.) pipes, laid on a minimum gradient of 2½%, from oblique branches on the sewer to siphon intercepting traps near the house, as shown by Fig. 17. From this trap a 10-cm. fire-clay inspection pipe is carried up and capped at the sidewalk level with a cast-iron box having a locked cover. From this inspection pipe a branch is connected to a cast-iron fresh-air inlet, in most cases set in the wall of the house, the inlet being 30 cm. above the level of the pavement.

Effect of the Flood on Sewers.—The flood of August 27th and 28th, 1909, partly destroyed one of the main collectors, which was laid along the banks of the river and encased in concrete. This has now been relaid farther north, and out of the way of any future floods. The total length of the new sewers replacing those damaged amounts to 1 200 m., and they vary in internal diameter from 20 to 55.9 cm. (8 to 22 in.).

MAIN OUTFALL SEWER.

The direction of the main outfall sewer was determined after a thorough study of all the available land lying to the north and northeast of the city, as it was the intention of the Company to utilize

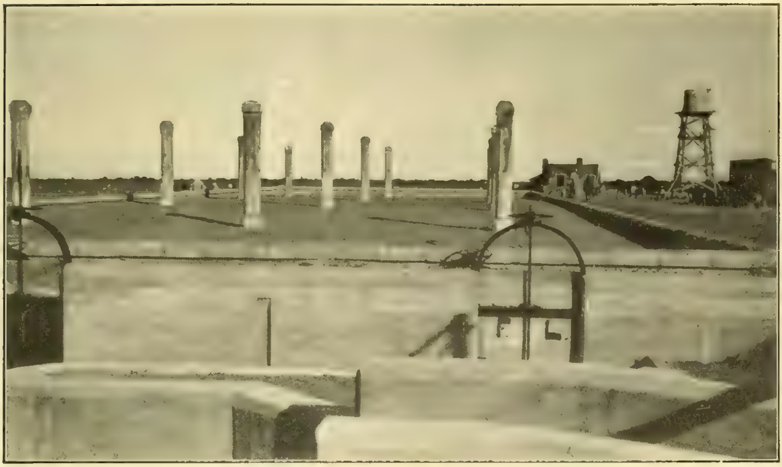


FIG. 1.—VIEW OF LIQUEFYING TANKS, FROM INLET END.

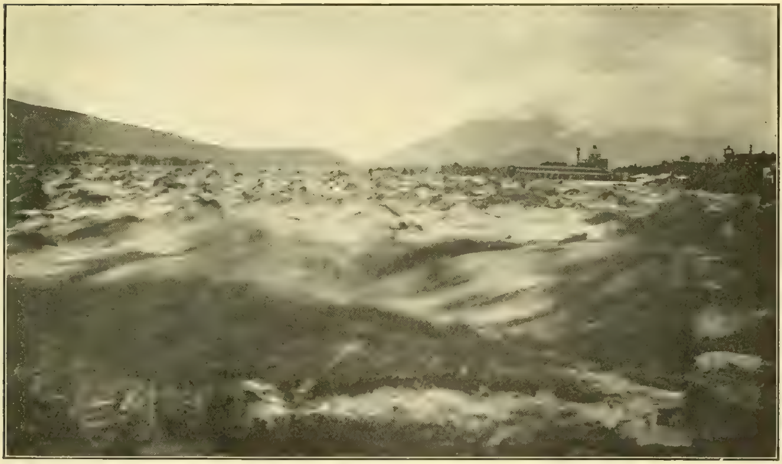


FIG. 2.—VIEW OF SANTA CATARINA RIVER IN FLOOD, ON AUGUST 28TH, 1909.

for irrigation purposes the sewage and any surplus waters that might be developed. The best available site was found to be about 12 km. north of the city, a little northwest of the village of San Nicolas de los Garzas, as shown on Plate CLXXX. The long length of outfall required was justified by the cheap cost of the land and its excellent character for sewage irrigation. The sewer was designed for a capacity of 90 000 000 liters a day (36.76 cu. ft. per sec.) in order to allow for conveying surplus waters as well as sewage.

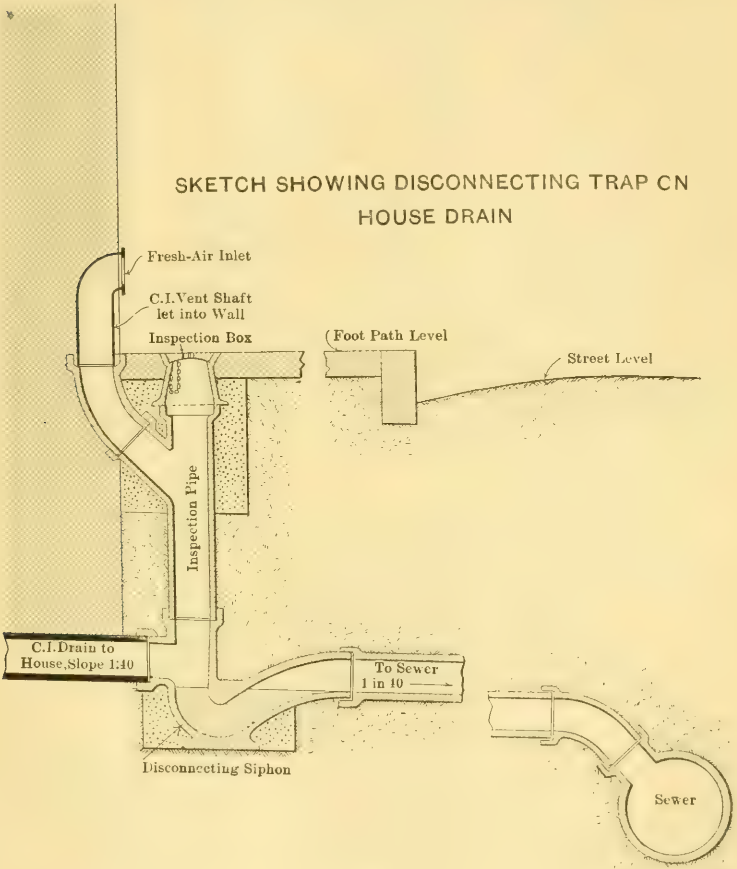

SKETCH SHOWING DISCONNECTING TRAP ON HOUSE DRAIN

FIG. 17.

The outfall intercepts the two main branches of the city sewers at Calle de Allende and Calle de Tapia, and its total length is approximately 11 900 m. The chief type adopted is shown on Plate CC. It is formed with an invert of radial bricks laid in 1: 2 cement mortar, on a foundation of 1: 3: 5 concrete approximately 7 cm. thick. As the ground was chiefly in hard sillar, only a little concrete was required to mould the bottom to the correct shape. The arch was formed of special radial bricks, 15 cm. (6 in.) deep, laid in cement mortar. These bricks were adopted in preference to concrete, owing to the heavy cost of sand and rock, due to the long haul, and for the purpose of obtaining rapid work. Plate CXCIX shows the sewer arch, and one of the ventilating columns and manholes. The bricks were obtained from the local brick plant, and form a very satisfactory material for sewers, being well burnt, thoroughly hard, and absorbing not more than 7½% of their weight of water. The contract prices for the labor on the brickwork were 1.25 pesos per sq. m., and 1.38 pesos for the arch.

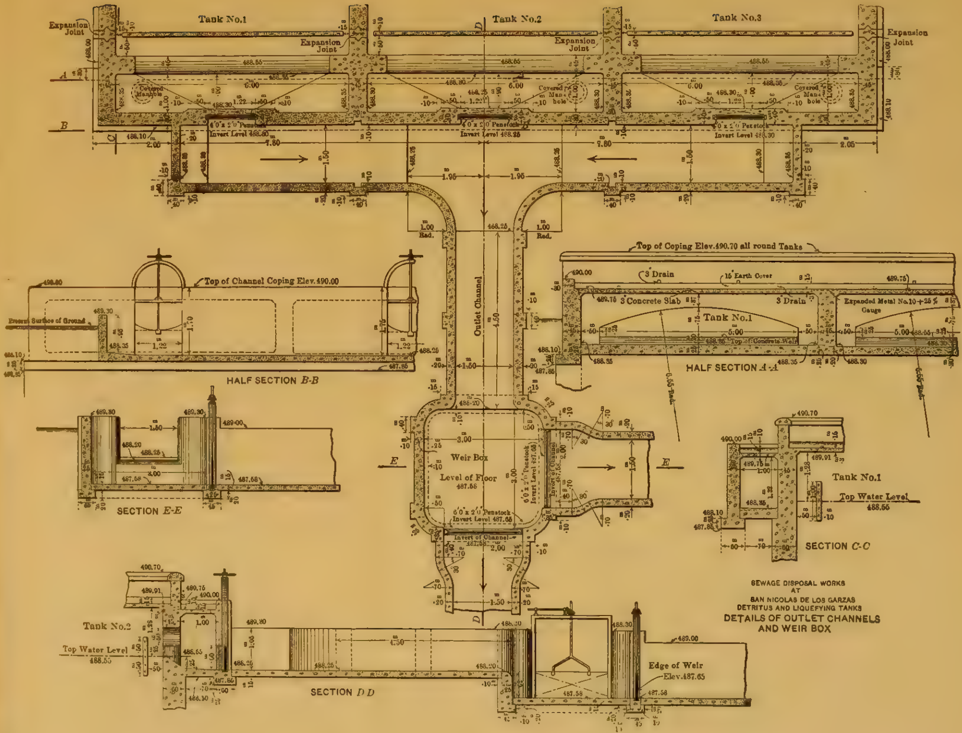
The general route of the sewer is very direct, long straight lines of several kilometers being possible, and these were joined by curves of approximately 30 m. radius. The gradient of the sewer invert is 0.2% (1 in 500) which is approximately the general fall of the ground northward from Monterrey.

The total quantity of excavation was as follows:

No. 1, soft earth	8 960	cu. m.
No. 2, sillar	18 492	" "
No. 3, conglomerate rock	9 822	" "
Total	37 274	cu. m.

The contract prices for this excavation were: for No. 1, 32 cents; No. 2, 85 cents; and No. 3, 2.17 pesos per cu. m.

All the excavation was in perfectly dry ground. Where the sewer was partly out of the ground it had a foundation of concrete, 1.75 m. wide, from 15 to 23 cm. thick, below the bottom of the brickwork, and carried up to the springing of the arch, and a well-tamped embankment, with slopes of 1½ to 1, to protect the sewer to a height of 30 cm. (12 in.) above the arch. For 342 m. at the Monterrey end of the line, the sewer was constructed in tunnel, from the open end and from two intermediate shafts. The tunnel throughout was in sillar, and the contract price for excavation was 24.50 pesos per lin. m. This work was done without timbering of any kind, except at the shaft lengths. Plate CC shows


Tank No.1
Tank No.2
Tank No.3
Expansion Joint
Covered Manhole
4'0" x 2'0" Penstock Invert Level 488.30
4'0" x 2'0" Penstock Invert Level 488.25
4'0" x 2'0" Penstock Invert Level 488.30
1.00 Rad.
Outlet Channel
Top of Channel Coping Elev. 490.00
Present Surface of Ground
HALF SECTION B-B
Top of Coping Elev. 490.70 all round Tanks
3" Drain
15" Earth Cover
3" Concrete Slab
Expanded Metal No.10 + 25% Gauge
Top of Concrete Weir
HALF SECTION A-A
SECTION E-E
Weir Box
Level of Floor 487.65
6'0" x 2'0" Penstock Invert Level 487.65
Invert of Channel 487.65
SECTION C-C
Top Water Level 488.55
SECTION DD
Edge of Weir Elev. 487.65

SEWAGE DISPOSAL WORKS
AT
SAN NICOLAS DE LOS GARZAS
DETRITUS AND LIQUEFYING TANKS
DETAILS OF OUTLET CHANNELS
AND WEIR BOX

the lining of the tunnel, which was of concrete with a brick invert. At four places the sewer passes under main railway tracks, which at these points were carried on steel girders supported on concrete abutments, the sewer being carried under the tracks in the ordinary way.

Bridges.—At three points the sewer was carried over arroyos on reinforced concrete girders. No. 1, at Station 5 600, consisted of four 10-m. spans; No. 2, at Station 8 365, over the Estancia Arroyo, consisted of nine 10-m. spans; and No. 3, at Station 8 960, over the Topo Chico Arroyo, consisted of three 10-m. spans. Two of these bridges are shown on Plate CCI. They were designed as two parallel continuous girders with connecting top and bottom slabs. The concrete for the girders was a 1 : 2½ : 3½ mixture, the sand being from the crusher and the rock gauged to pass a 19-mm. (¾-in.) screen. The inside was rendered with a coat of 1 : 1 cement mortar, 7 mm. thick, for watertightness.

The piers of the Estancia Bridge (Plate CCI) were carried down through soft earth to a stiff clay from 4½ to 6 m. below the surface, and the foundations were spread so that the pressure would not exceed 1 ton per sq. ft. The ends of the bridges were protected by rubble wing-walls supporting the embankment over the sewer. A 1 : 3 : 5 concrete was used for the upper part of the piers, and the lower part was of the same mixture with 30% of large boulders. There are 70 manholes (Fig. 19) along the line of the sewer, and they vary from 150 to 230 m. apart. The sewer is ventilated with 30 concrete towers (Fig. 18, and Fig. 2, Plate CXCIX), 2.9 m. high, having 20-cm. (8-in.) shafts.

The works for the outfall sewer were carried out satisfactorily under a contract with Mr. John Phillips, of Mexico City, the Company supplying the greater part of the materials. The work was begun on March 16th, and finished on November 12th, 1908.

SEWAGE DISPOSAL WORKS AND IRRIGATION LANDS.

For the purpose of disposing of the sewage and using it profitably, the Company purchased 909 hectares (2 246 acres) of land from the Community of San Nicolas de los Garzas, the outfall sewer being carried to the southwestern boundary of the land acquired. This area has a general fall in all directions to the northeastern boundary, with a gradual fall of about 25 m. across the diagonal of the land. The area purchased was practically virgin land, only small portions having been cultivated. The greater part was covered with a growth of mezquite trees and small shrubs. The quality of the land is excellent, if properly irrigated, and capable of yielding abundant crops of every description. The limits of this land are shown on Plate CLXXX.

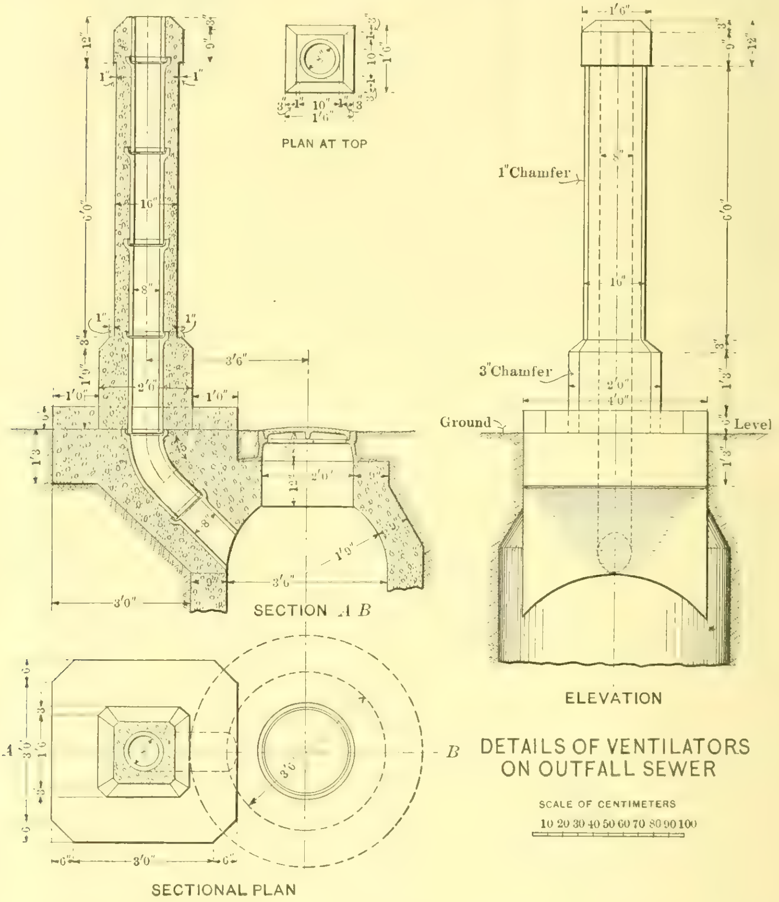
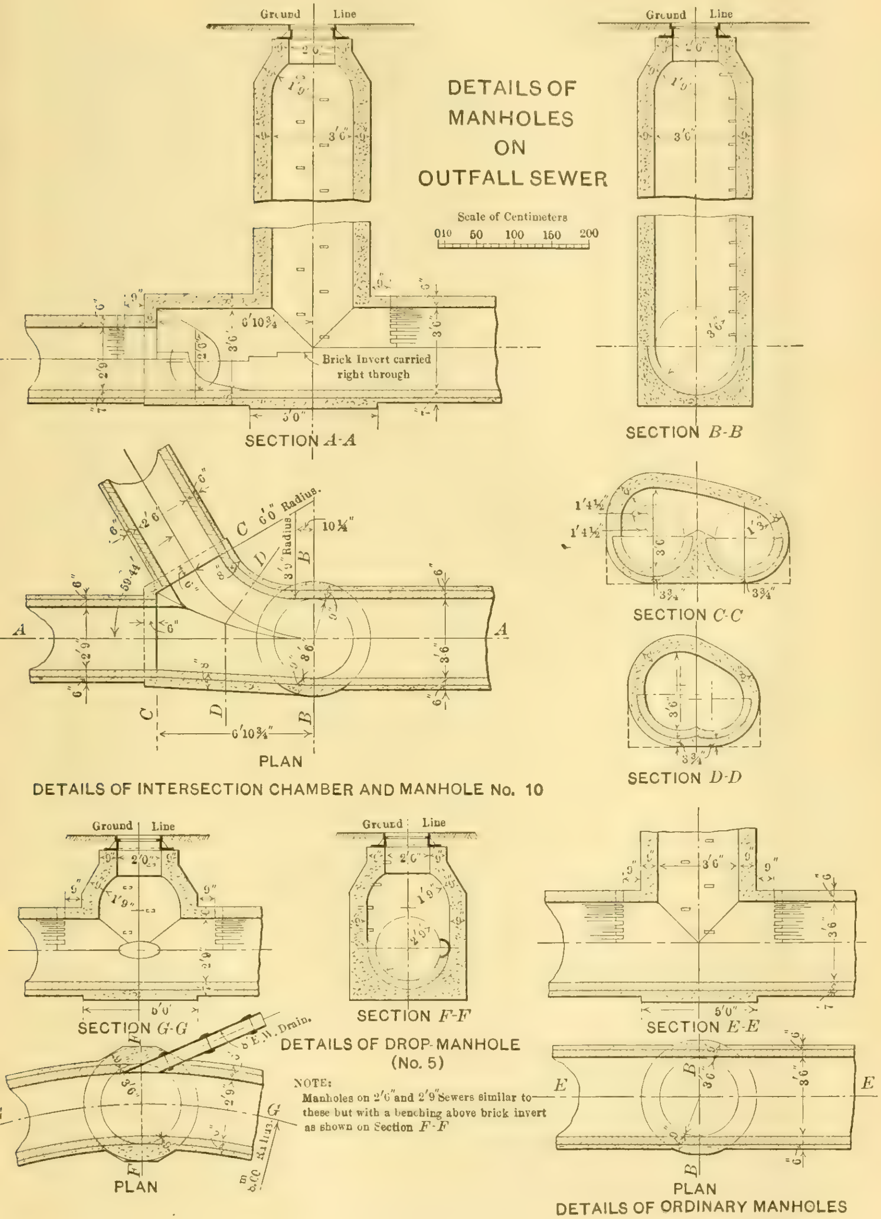


Fig. 18.

Sewage Purification Tanks.—For the purpose of obtaining a satisfactory effluent to discharge on the land without causing nuisance, the Company built a system of detritus chambers and liquefying tanks at the end of the outfall sewer. One difficulty to be faced, in designing these works, was the fact that there were no data regarding the probable quantity of dry-weather sewage, nor any particulars as to its general



DETAILS OF MANHOLES ON OUTFALL SEWER

DETAILS OF INTERSECTION CHAMBER AND MANHOLE No. 10

DETAILS OF DROP-MANHOLE (No. 5)

NOTE: Manholes on 2'6" and 2'9" Sewers similar to these but with a benching above brick invert as shown on Section *F-F*

DETAILS OF ORDINARY MANHOLES

FIG. 19.

character; there was also the probability that the outfall sewer would have to carry large quantities of surplus water. Therefore, the system was designed so as to be capable of extension if necessary, and the sizes of the various tanks were limited at present, because of the septic processes which would be set up in the long length of outfall sewer. The tanks were designed to deal with 10 000 000 liters of sewage proper per day, and the channels, etc., were proportioned to take the full flow of the sewer if necessary. Provision was also made for discharging large volumes of surplus water directly on the land, independent of the tanks. To do this a by-pass was taken from the sewer a short distance before reaching the site of the tanks. By properly timing the flow, arrangements could be made to discharge these waters in the early hours of the morning, by allowing the scour-pipes in the distribution system to be opened at night when the domestic sewage flow was at its minimum. As the area of land available is very great, the degree of purification in the tanks was relatively unimportant; the object to be obtained consisted chiefly in distributing on the land an effluent which would be innocuous and clear.

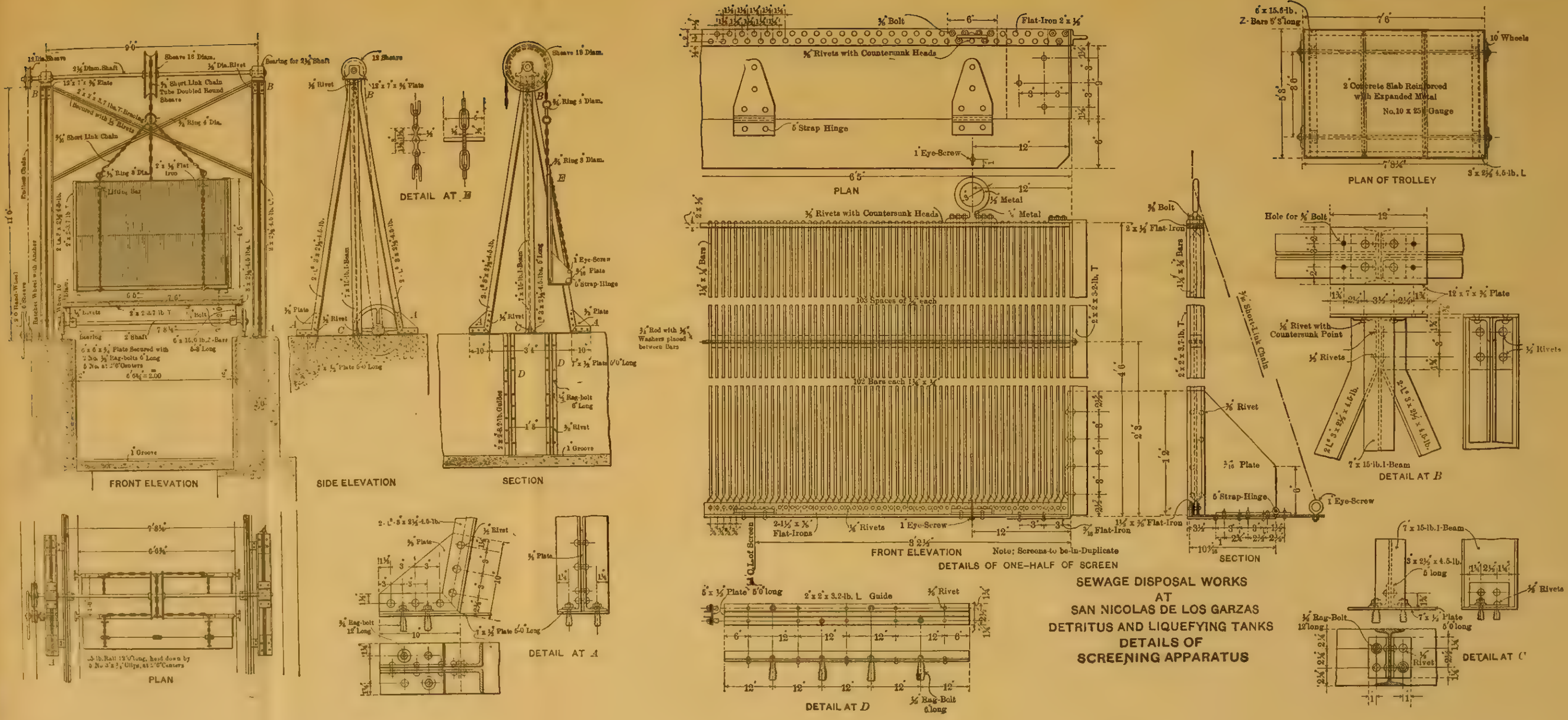
The general design of the works is shown on Plate CCII, and they consist essentially of a screen chamber, duplicate detritus tanks, and three liquefying tanks. There is also a sludge-pit 629 m. from the tanks.

Screen Chamber and Detritus Tanks.—Enlarged details of the screen chamber are shown on Plate CCIII. The invert where the sewer enters the screen chamber is 489.45 m. above datum. This chamber has duplicate screens which are fully detailed on Plate CCVIII. For cleaning purposes the screens are raised by a steel-framed head-gear, which is arranged so that they may be lowered to a small traveling bogie, out of the way of the screen chamber.

From the screen chamber there are two main channels, 1.22 m. wide, branching to the two concrete detritus chambers. Each channel has a square penstock, so that the sewage can be diverted into either chamber when necessary.

The detritus chambers are octagonal in plan, 4 m. in diameter, and each is provided with an outlet weir 1.50 m. wide. At the weir level the chambers have a depth of 1.75 m., with drainage channels below that level. The coping is 1 m. above the outlet weir of the detritus tanks. To drain off these chambers, each has a scour-out pipe, 30 cm. in

PLATE CCVIII.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.



SEWAGE DISPOSAL WORKS
AT
SAN NICOLAS DE LOS GARZAS
DETRITUS AND LIQUEFYING TANKS
DETAILS OF
SCREENING APPARATUS

diameter, controlled from valves with spindles carried above the coping level. Each of these pipes is connected to a central chamber and leads to a 56-cm. (22-in.) sludge-pipe. The chambers as designed are of smaller capacity than those usually provided, but, as all surface water is strictly excluded from the sewerage system, the quantity of detritus reaching the chambers may be small. The velocity through them when both are in use will be approximately 0.082 m. (0.27 ft.) per sec.

From these chambers the sewage is carried to the three liquefying tanks by a main channel, 11.5 m. long and 1.50 m. wide.

The tanks are of concrete and have reinforced concrete roofs. Each is 66 m. long and 6 m. wide; the minimum depth for the sewage is 1.50 m. at the outlet end, and 2.25 m. at the inlet, increasing to a maximum depth of 2.75 m. at the lowest depth at the scour-out channel. Their combined capacity is 2 500 000 liters, which is equivalent to 6 hours' flow of the quantity of sewage for which they were designed. The sewage passes from the main channel, through penstock-valves which control the flow, into one or the other of the tanks. From these valve openings it flows over concrete weirs, 5 m. long, and is deflected to the bottom of the tank by a reinforced concrete scum-plate extending across each tank with a clearance of 15 cm. at each end. This scum-plate is 1.5 m. deep and 10 cm. thick, and is placed 40 cm. from the end walls.

The details of the concrete division and outside walls are shown on Plate CCVII. The floor was constructed in two lawyers, and its surface is divided into 6 channels formed by small walls, 20 cm. wide and 15 cm. deep, the object of these channels being to facilitate the cleaning of the floor by scouring it out to a specially arranged channel at the deepest point of the tank, near the inlet end. Each scour-out channel has a 30-cm. (12-in.) gate-valve, controlled from the roof of the tank, the three scour-pipes meeting in a concrete chamber outside of the tanks, from which a 56-cm. (22-in.) concrete pipe discharges the contents of the tanks to the sludge-pit during cleaning operations. The velocity through the tanks, when they are used in combination, is 0.0253 m. (0.083 ft.) per sec., the tanks being made as long as economically possible, in order to obtain this low velocity and thus permit the proper sedimentation of the suspended matters. The roof of each tank is 1 m. above the weir level. Each tank has four ventilating columns, 3.7 m. high and 30 cm. in diameter, vitrified clay pipes, with an exterior casing of concrete, being used for the shafts. The roof is enclosed within parapet walls, and is covered with a layer of earth 25 cm. thick.

The outlet channel from the tanks leads to a measuring chamber, 3 m. square, as shown on Plate CCVII. This chamber is fitted with penstocks, 1.83 m. wide, and measuring weirs. From this chamber the sewage is delivered to two main irrigation ditches, which distribute the sewage in two directions, one northward and the other to the western extremity of the lands.

Construction of Tanks.—The excavation for the tanks was in soft earth for a depth of 1½ m.; the lower depths were in a firm foundation of sillar and calcareous clay. The total excavation in the tanks, channels, etc., was 8 335 cu. m., and the actual cost was 45¾ cents per cu. m. To facilitate the construction, about six-tenths of the concrete beams were cast as single monoliths and placed in position by sliding them across the tanks on temporary timbers. The remainder of the beams, the roof, and the slab were placed in position in the ordinary way with timber forms. The total quantity of concrete placed was 1 360 cu. m. A 1 : 2½ : 4½ concrete was used for the walls, channels, etc., and a 1 : 2 : 3 mixture for the roof slab and beams.

Table 14 gives the average cost per cubic meter for all the concrete work.

TABLE 14.—AVERAGE COST PER CUBIC METER FOR CONCRETE IN TANKS.

	Pesos per cubic meter.	Pesos per cubic meter.
LABOR:		
Mixing and placing	5.20	
Carpenter work in forms, framing, etc	4.20	
Total labor cost		9.40
MATERIALS:		
Screened gravel	4.04	
Sand (from neighboring arroyo)	4.98	
Cement (including hauling)	15.19	
Lumber, nails, and other supplies	1.90	26.11
Total cost of concrete per cubic meter		35.51

Sludge-pit.—The sludge-pit, used when cleaning out the tanks, is carried 639 m. northward, far enough to get the available fall to drain the bottom of the detritus chambers and liquefying tanks. The drain-

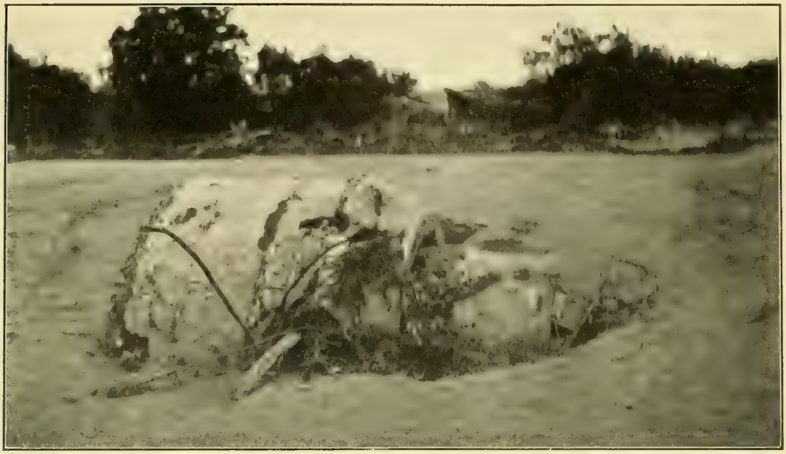


FIG. 1.—FLUSH-TANK CARRIED DOWN BY FLOOD OF AUGUST 27TH-28TH, 1909.

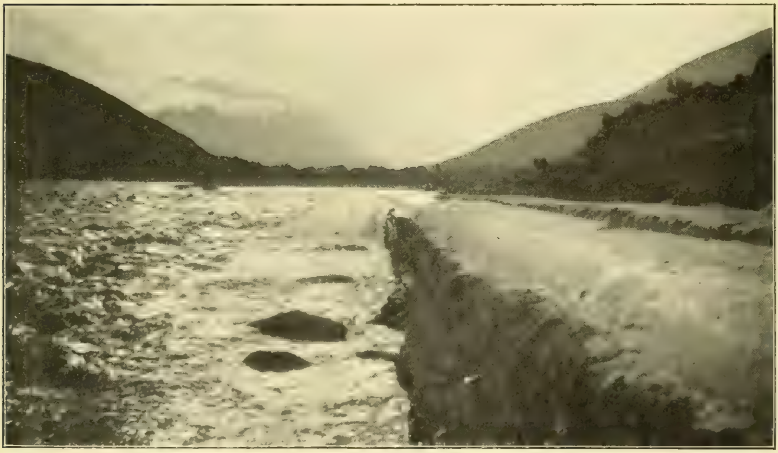


FIG. 2.—VIEW SHOWING SCOURING EFFECT OF FLOOD ON SAN GERONIMO AQUEDUCT.

age pipe was formed of 56-cm. (22-in.) concrete tubes. The sludge-pit is merely an excavation in the earth 20 m. square and 2 m. deep, the sides having a slope of 1½ to 1. An overflow drains the pit to an irrigation ditch, the solid matter being allowed to settle and the liquid to drain off. From time to time it is proposed to dig out the solids and plow them into the land.

General.—To the east of the tanks a 3-roomed house has been built for the inspector.

In order to provide a good supply of water for cleaning operations, a well 22 m. deep has been sunk and is fitted with pumps operated by an Eclipse windmill, 4 m. in diameter, on a tower 22 m. high, which delivers the pump water to a circular wooden tank of 20 000 liters capacity.

The work in connection with the purification tanks was carried out by the Company's own staff; it was begun on September 10th, 1908, and practically completed by the first week in January, 1909.

At the time of writing, the tanks have to deal with the sewage from a population of only 10 000 persons, as only from 15 to 20% of the connections have been made. The sewage, therefore, has been diluted with several times its volume of surplus water, and the necessary scum on the top of the sewage in the tanks has not yet assumed the usual thick matty condition observed in most systems. As there are no available means in Monterrey of having proper determinations made of the degree of purification which takes place in the passage of the sewage through the liquefying tanks, a few simple tests have been made. These tests were limited to the determination of the amount of oxygen absorbed in 4 hours, and show a purification of 50% in passing from the detritus chambers to the outlet. The sewage, although very black and full of suspended matter as it enters the tanks, leaves them in a very clarified condition.

Of the total area of land acquired by the Company, 904 hectares (2 234 acres) have been leased to the Monterrey Railway, Light, and Power Company, for 99 years, the Water-Works Company reserving 5 hectares (12 acres) absolutely for future extensions of the sewage works. By giving 12 months' notice, the Company also reserves the right to utilize any part of 145 hectares (358 acres) near the tanks, should it be required at any time in the future for sewage purification purposes.

QUALITY OF AND RATES FOR LABOR.

All the work was practically under the direction of English-speaking superintendents and general foremen. For the ordinary skilled and low-skilled labor, Mexicans were employed exclusively, and, on the work which was quite new to them, they proved entirely efficient and satisfactory; throughout the work, on which at some periods between 2 000 and 3 000 men were employed, chiefly under the Company's direct administration, they were very tractable and willing to do their best, and no trouble was experienced at any time. The Mexican "peon," and also the ordinary skilled workman in the north of Mexico, is intelligent, and is excellent for purely routine work, but he is not adaptable or resourceful in cases of emergency. Under intelligent and careful supervision, however, it is quite possible to get as good results as could be obtained anywhere.

The daily rates of wages for a 10-hour day were approximately as given in Table 15, these rates being varied in special cases.

TABLE 15.—RATES OF WAGES.

	Pesos per day.
General foreman	8.00 to 10.00
Foreman	6.00 " 8.00
Cabos	2.00 " 4.00
Masons	3.00 " 4.00
Bricklayers	3.00 " 4.00
Masons and bricklayers, helpers	1.50
Cast-iron pipe jointers (foreman)	4.50
" " caulkers	3.00
" " helpers	1.50 to 2.00
Fire-clay pipe layers	1.75
" " helpers	1.25 to 1.50
Drillers	1.25 " 1.50
Carpenters	2.00 " 2.50
Blacksmiths	2.50
Crane men	6.00
Peons (laborers)	1.00 to 1.25
Boys (watering concrete)	0.37½ " 0.50
Watchman	1.00
Timekeepers	22.00 per week.

COST OF WORKS.

Table 16 gives the main items of the approximate expenditure. These include all expenses for preliminary location, engineering, superintendence, purchase of lands, water rights, etc., but do not include other heavy expenditures chargeable to the concession, such, for example, as general expenses, interest at the rate of 6% during the con-

PLATE CCX.
PAPERS, AM. SOC. C. E.
DECEMBER, 1910.
CONWAY ON
WATER-WORKS AND SEWERAGE OF MONTERREY.

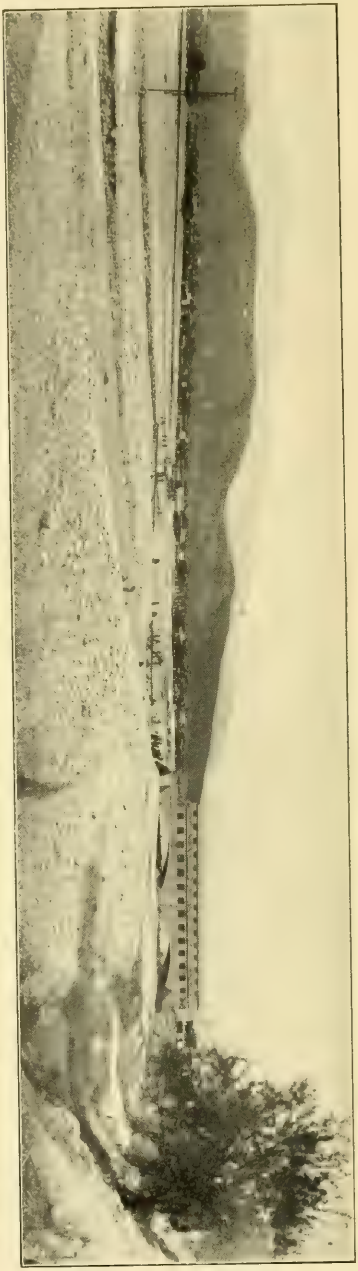


FIG. 1.—VIEW OF SANTA CATARINA RIVER AFTER THE FLOOD.

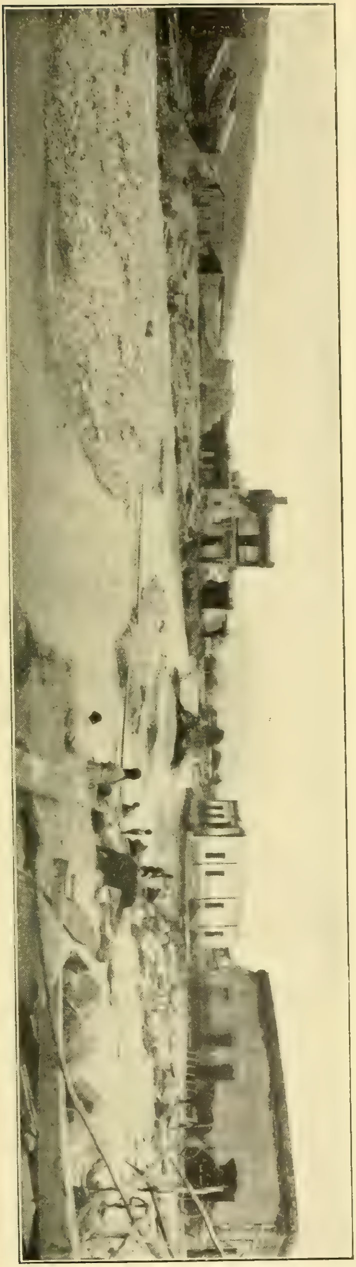


FIG. 2.—VIEW OF SANTA CATARINA RIVER FLOWING THROUGH LOW-LYING STREETS, 8 DAYS AFTER THE FLOOD.

struction period, preliminary expenses for investigations, etc., items which would increase the total by nearly 25 per cent.

TABLE 16.—PRINCIPAL ITEMS OF EXPENDITURE.

	Pesos, Mexican currency.	
ESTANZUELA SUPPLY:		
Aqueduct and dam	502 000	
South Reservoir	429 000	931 000
SAN GERONIMO GRAVITY SUPPLY:		
Aqueduct, tunnel, and infiltration gallery	223 000	
Obispado Reservoir	436 000	659 000
SAN GERONIMO PROVISIONAL SUPPLY, including boring operations, etc		130 000
CITY WATER DISTRIBUTION SYSTEM		1 195 700
CITY SEWER SYSTEM		1 036 000
OUTFALL:		
Main outfall sewer	425 000	
Sewage purification works	75 000	500 000
Total		4 451 700

As a general statement, the actual cost of labor is about 33⅓% of the total cost of the construction work, including materials. Fig. 20 shows in graphic form the amount of the labor pay-rolls and the progress of the work during the whole construction period from 1906 to 1909, inclusive, comprising also that done under contract.

TARIFFS AND SANITARY REGULATIONS.

Tariffs.—The tariffs charged for the water and drainage service (Table 17) were approved by the State Government (which accepts the responsibility for their collection), under a compulsory State law which came into force on March 1st, 1910, for the southern portion of the city, and on July 1st, for the northern half, the penalty for non-compliance being a tax of 10% on the monthly rental value of the property, as assessed by the State officials.

The basis of the tariffs (which were published on February 22d, 1909) is a charge for water varying between 12 and 16 cents (Mexican) per 1 000 liters, with a minimum monthly rate for each different class of property connected to the system. The rate for house drainage is fixed at 80% of the minimum water rate levied on the consumer. The minimum rates have been fixed so that the poorer classes of the community will not be overtaxed, while at the same time the rate is actually levied on the quantity of water used, as indicated by the meter. All the services at the present time are metered, and the meter system will be used throughout.

TABLE 17.—THE TARIFFS.

Class.	Monthly property rental. Pesos.	Liters of water allowed.	Price for 1 000 liters. Cents.	Minimum monthly rate. Pesos.	Rate for drainage service. Pesos.	Total rate payable. Pesos.
I...............	Up to 20	7 800	16	1.25	1.00	2.25
II...............	21 to 40	12 500	16	2.00	1.60	3.60
III...............	41 to 60	18 750	16	3.00	2.40	5.40
IV...............	61 to 120	23 350	15	3.50	2.80	6.30
V...............	121 to 300	30 000	15	4.50	3.60	8.10
VI...............	301 upward.	33 350	15	5.00	4.00	9.00

"Notes: (1st) The rental for the water meters $\frac{5}{8}$-in. size ($15\frac{1}{2}$ mm.), which shall always be considered the property of the Company, will be 20 cents per month. Houses of the first and second classes shall be exempt from paying such rental for one year's time, counting from this date.

"(2d) All excess consumption of water over that allowed by the tariff will be charged for at 2 cents less than the price shown in the tariff per thousand liters.

"(3d) Extra large houses, large establishments, such as colleges, hotels, etc., etc., having a consumption of 50 000 to 60 000 liters of water per month, will pay at the rate of 14 cents per thousand liters. The drainage rate for such buildings will be arranged in proportion to the water tariff, or 80% of the value of the water.

"(4th) The laundry establishments, bath-houses, etc., when using 50 000 liters or upward, can arrive at some agreement so as to pay 12 cents per 1 000 liters.

"(5th) Groups can be formed of two or more small houses so as to obtain a joint service under the proportion shown in the tariff.

"(6th) Any other combination that cannot be entered into under the basis of this tariff, will be arranged by specially agreed upon prices, such agreement being as much as possible subject to the basis mentioned."

Sanitary Regulations.—The State Government, on March 1st, 1909, published regulations for the proper installation of the water and drainage services within the houses.

At the Government's request, a draft of the proposed regulations was submitted by the writer, who prepared it, after a study of American

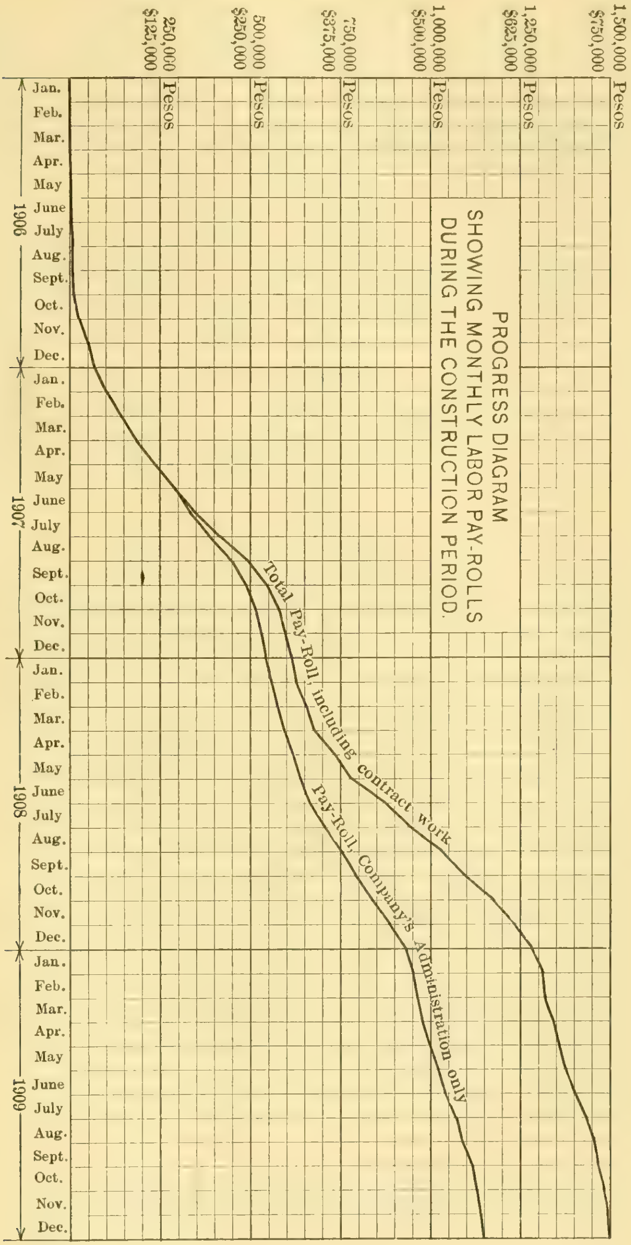

PROGRESS DIAGRAM
SHOWING MONTHLY LABOR PAY-ROLLS
DURING THE CONSTRUCTION PERIOD.
250,000 Pesos
$125,000
500,000 Pesos
$250,000
750,000 Pesos
$375,000
1,000,000 Pesos
$500,000
1,250,000 Pesos
$625,000
1,500,000 Pesos
$750,000
1906
1907
1908
1909
Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Total Pay-Roll, including contract work
Pay-Roll, Company's Administration only

FIG. 20.

and British sanitary by-laws, to suit the special conditions of Monterrey. These regulations were afterward modified by him in collaboration with the Government Technical Inspector and Financial Interventor, and, in their final form, though not as stringent as those adopted in many northern cities, are probably more complete than those in any other Mexican city. Under these regulations only registered plumbers can undertake plumbing installations, and they have to execute a bond to the satisfaction of the *Alcalde Primero* (City Mayor) for the sum of 2 000 pesos as a guaranty of responsibility. For defective workmanship or any infraction of the plumbing regulations, they are liable to heavy fines, and can be called on to make good all defects in workmanship, without extra charge to the owner of the property. The provisions of the regulations are carried out under the supervision of the Government Technical Inspector, the Company's obligations extending only to the sidewalk and to the meters placed within the houses.

ENGINEERS, ETC.

G. S. Binckley, M. Am. Soc. C. E., was Chief Engineer of the Company from February to December, 1906. The writer was Chief Engineer from May 1st, 1907, until April, 1910, and is responsible for the design and construction of the works carried out during that period. Mr. J. D. Schuyler advised the Company throughout all preliminary studies and investigations, and acter as Consulting Engineer until February, 1908. The Technical Inspector, on behalf of the Government, throughout the whole progress of the works, has been Rudolf Meyer, M. Am. Soc. C. E., and the writer wishes to record the valuable assistance the Company has received from him.

In conclusion the writer may be permitted to pay a tribute to the devoted public spirit shown by his Excellency, General Bernardo Reyes, the Governor of the State of Nuevo León from 1885 to February, 1910, and who, untiring in his devotion to the interests of the city, was primarily responsible for the inception of the works and their successful completion.

Vol. XXXVI. DECEMBER, 1910. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852.

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

A THEORY OF THE WATER WAVE.*

By Morton F. Sanborn, Assoc. M. Am. Soc. C. E.

While studying the vertical circulation of the water in the Charles River Basin,† near Boston, Mass., the writer thought that there must be a simple theory of wave action, and so has undertaken to find that theory, the results of his conclusions being contained in the following paper.

No attempt has been made to go into the deeper mathematical problems connected with the theory; only a general statement that may be useful to engineers is given here.

The writer has not been able to do much experimental work; but has secured his data largely from a paper‡ by Captain D. D. Gaillard, now Lieutenant-Colonel, Corps of Engineers, U. S. Army. Captain Gaillard's paper contains a large amount of information, obtained from his own experiments and from other sources.

The following theory is based on the fact that water will move in the direction of least resistance, following the law that a column of water in a bent tube will oscillate up or down in one side in the same time that a pendulum, which is one-half the length of the column of water, will swing; the theory is also based on other well-known facts and laws.

---

* This paper will not be presented at any meeting, but written communications on the subject are invited for publication with it in *Transactions*.

† "Distribution of Sea Water in the Charles River Basin After Excluding Tidal Waters," *Engineering News*, March 10th, 1910.

‡ "Wave Action in Relation to Engineering Structures," Professional Paper No. 31. By Captain D. D. Gaillard, Corps of Engineers, U. S. Army.

The theory that the motion of the particles of water in a wave is in a circle or ellipse, and even approaches a straight line, for waves in shallow water, is accepted, as all experiments have shown that to be the case.

THEORY OF MOTION OF DEEP-WATER WAVES.

Fig. 1 represents a trough, *AB,* with a gate, *CD,* which can be raised. The water stands at the height, *H,* on the left of the gate and at the height, *h,* on the right. When the gate, *CD,* is raised so that the bottom will be at *E* the water at the left of the gate will settle down, some of it flowing out under the gate, raising the water on the right, and causing it to take a form somewhat like *FKL.*

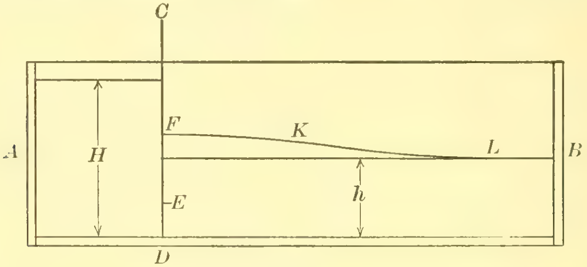


FIG. 1.

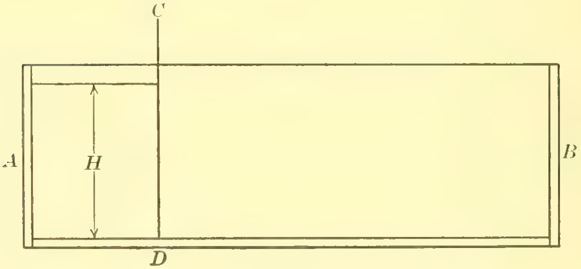


FIG. 2.

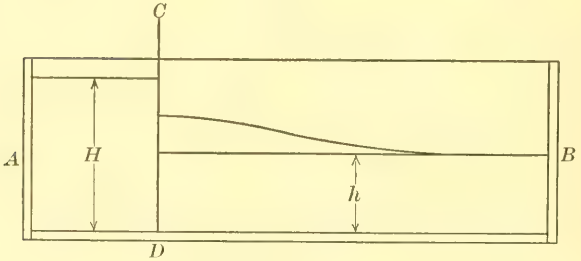


FIG. 3,

The water at the left of the gate will settle until it has lost its motion, as in the bent tube, then it will rise again, and keep falling and rising until the resistance has overcome the power of motion, and the water will stand level in the trough. This action will be called one of displacement, where the motion is communicated through the water to water at a distance.

Fig. 2 is the same trough with no water on the right of the gate. When the gate, *CD,* is raised clear of the trough, the water to the left will flow toward the end, *B*. This action will be called one of flow.

In Fig. 3 there are the same conditions as in Fig. 1, but when the gate, *CD,* is lifted clear of the trough, the resulting action is one of both flow and displacement, and the result is a wave, the flow starting immediately, and the action is similar to that in the crest of a wave. The displacement is felt in advance of the crest, and is shown by the upward motion of the water. The motion of the particles of water in a wave is due to the resultant of these two forces, namely: By flow, which gradually decreases while the displacement or vertical motion increases, and then the reverse action.

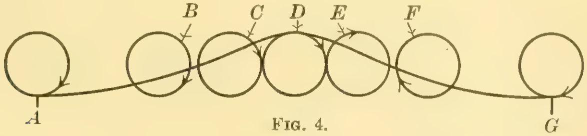


FIG. 4.

Although the forces that act on the particles of water in a wave are of flow and displacement, they are also dependent on the action of every other particle in the complete wave, and it is their united action which produces the regular waves seen after a storm.

Whether the wave is caused by the wind or by some object placed in the water, it is forced to go away from the disturbance just the same as in the case of the trough.

Fig. 4 shows the direction of motion of the particles of water on the surface of a complete wave:

Particle *D* is affected only by flow, so that it travels horizontally and not vertically, as it has lost its upward motion and has not acquired a downward motion.

Particle *E,* being in advance of the highest part, has not yet acquired its full flow, and, as it is approaching the highest position, has lost some of its upward velocity; the resultant is shown by its position on the circle.

Particle *F* is so far in advance of the crest that it is not affected much by flow, and, being about half-way up, has attained its greatest upward velocity.

Particle *C*, the crest of the wave having passed, has acquired some velocity in a downward direction. It cannot fall in a vertical direction, on account of the horizontal motion given to it when at the top of the wave, and as the wave may be traveling at a uniform velocity of 20 or 30 ft. per sec., the water, to acquire that velocity in a downward direction, would have to separate itself from the wave and fall independent of it.

Particle *B* is half-way down, and has acquired its greatest downward velocity, but has no horizontal motion, as it is beyond the effect of the wave just passed.

The motion of Particle *A* is similar to that of *G*, as they are at the same point of the wave. They are at the lowest point in the trough of the wave, and therefore have no vertical motion. Their horizontal motion is about the same as when in the crest; but in the opposite direction, caused by suction to fill the positions left by Particle *F* and to make room for Particle *B*.

Velocity.—An examination of the movement of the particles of water in a wave, shows that the half nearest the crest is moving forward, while the half in the trough is moving backward. At the points of meeting of these two movements there is vertical, but no horizontal motion.

It is also seen that the half of the wave from the crest to the trough in front is moving upward, while the half from the crest to the trough in rear is moving downward, and it is this one-half length of the wave that is the base of the following formulas.

The number of seconds, *T*, required by water in a bent tube to rise or fall in one side is found by the following formula:

$$T = \frac{\sqrt{\frac{L}{2} \times 12}}{\sqrt{39.1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

In which T = the time, in seconds; and L = the length of the column of water, in feet.

Applying this formula to a wave gives:

$$T = \frac{\sqrt{\frac{L}{4} \times 12}}{\sqrt{39.1}}, \text{ or } 0.277 \sqrt{L} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In which L = the longitudinal length of the wave, in feet; and T = the time, in seconds, required by a particle to rise or fall.

The velocity of the wave is found by the formula:

$$V = \frac{L}{T} = \frac{\frac{L}{2}}{\frac{\sqrt{3L}}{\sqrt{39.1}}} = \frac{L\sqrt{39.1}}{2\sqrt{3L}} = 1.804\sqrt{L} \ldots\ldots (3)$$

The trochoidal formula for the velocity of a wave is:

$$V = \frac{\sqrt{gL}}{2\pi} = \sqrt{gR} = \sqrt{5.123\,L} \ldots\ldots\ldots\ldots (4)$$

In which g = the acceleration due to gravity, in feet per second;
L = the horizontal length of wave, in feet; and
R = the radius of the rolling circle, in feet.

For better comparing the two theories, the observed and computed velocities, taken from Table 1, were plotted on Fig. 5. The circles represent the observed lengths of waves and their velocities. The upper curve is the theoretical velocity, as determined by the trochoidal formula. The two lower curves were obtained from Formula 3, and represent the theoretical velocity.

It will be noticed that the trochoidal curve goes through the upper part of the observed velocities, while the curve by Formula 3 passes through the lower portion.

If a pendulum, with the best of bearings, is placed in a vacuum as nearly complete as possible, and started swinging, it will keep nearly perfect time for a few hours, or until the motion has stopped.

After a big storm, over deep water, it is many hours after the wind has stopped blowing before the wave motion has ceased. Why should not the deep-water wave keep as good time as the pendulum? Attention is again called to the fact that in Fig. 5 the theoretical velocity by Formula 3 passes through the lower part of the observed velocities.

Fig. 6 shows a pendulum at rest, with an air pipe and nozzle, *B*, and a valve, *C*, which shuts off the air current. By allowing the air

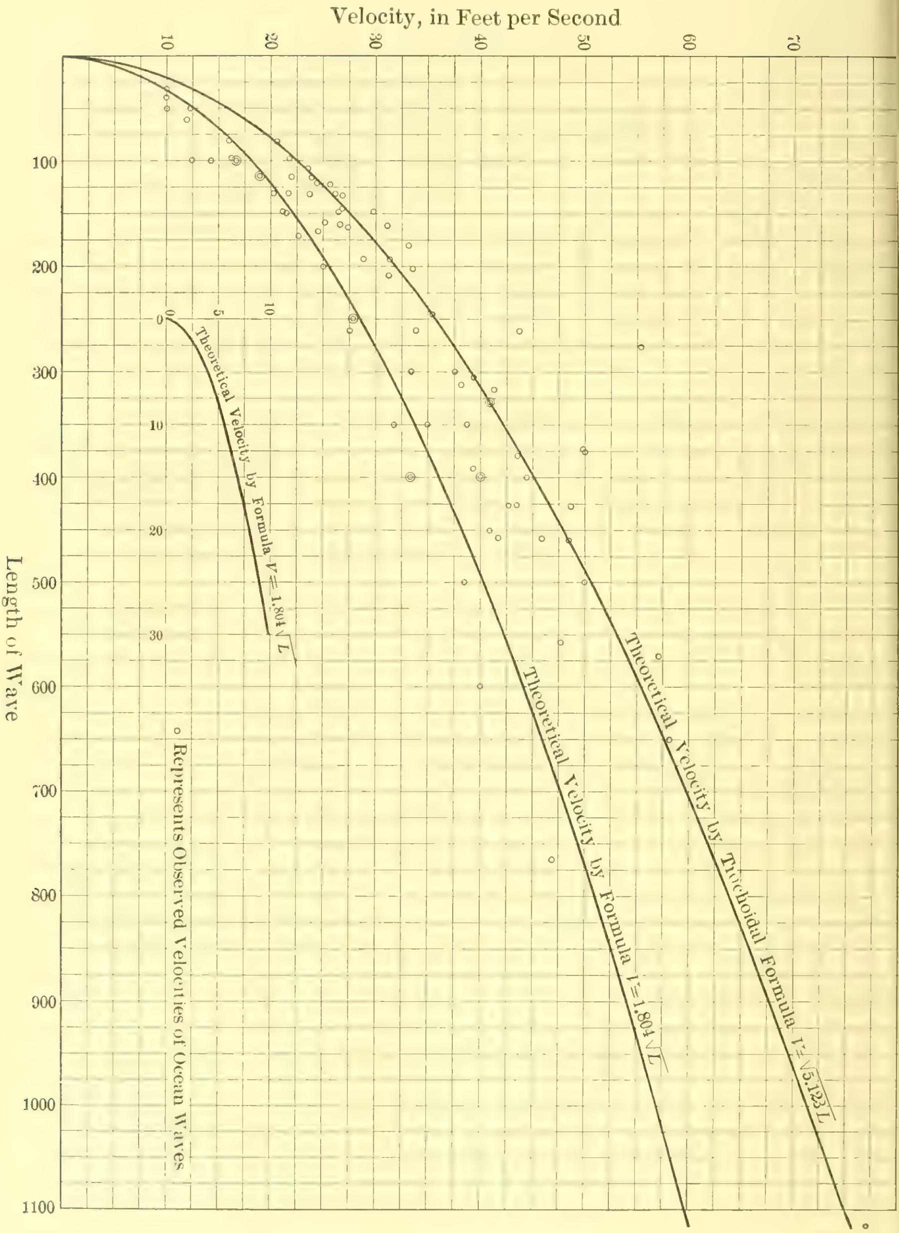

Velocity, in Feet per Second
10
20
30
40
50
60
70
Length of Wave
100
200
300
400
500
600
700
800
900
1000
1100
0
5
10
0
10
20
30
Theoretical Velocity by Formula V = 1.804√L
Theoretical Velocity by Formula V = 1.804√L
Theoretical Velocity by Trochoidal Formula V = √5.123 L
○ Represents Observed Velocities of Ocean Waves

FIG. 5.

TABLE 1.—COMPARISON OF OBSERVED VELOCITIES OF DEEP-WATER WAVES WITH THAT COMPUTED BY THE TROCHOIDAL THEORY AND BY FORMULA 3.

Wave height.	Wave length.	WAVE VELOCITY, IN FEET PER SECOND.				
		Observed.	Computed: $V=\sqrt{5.123\ L}$	Difference, columns (3) and (4).	Computed: $V=1.804\sqrt{L}$	Difference, columns (3) and (6).
(1)	(2)	(3)	(4)	(5)	(6)	(7)
24.6	1 121	77.3	75.8	— 1.5	60.4	—16.7
46.0	765	46.4	62.5	+16.1	49.9	+ 3.5
36.1	650	58.0	57.6	— 0.4	46.0	—12.0
37.5	600	40.0	55.4	+15.4	44.2	+ 4.2
13.1	571	57.1	54.1	— 3.0	43.1	—14.0
43.0	559	47.7	53.5	+ 5.8	42.6	— 5.1
25.0	500	38.5	50.6	+12.1	40.3	+ 1.8
4.0	500	50.0	50.6	+ 0.6	40.3	— 9.7
19.7	460	48.5	48.5	0.0	38.7	— 9.8
24.6	459	41.7	48.4	+ 6.7	38.6	— 3.1
14.4	459	45.9	48.4	+ 2.5	38.6	— 7.3
25.0	450	40.9	47.9	+ 7.0	38.3	— 2.6
26.2	428	48.2	46.8	— 1.4	37.3	—10.9
11.5	426	42.6	46.6	+ 4.0	37.2	— 5.4
9.8	426	43.5	46.6	+ 3.1	37.2	— 6.3
24.0	400	33.3	45.2	+11.9	36.1	+ 2.8
22.0	400	40.0	45.2	+ 5.2	36.1	— 3.9
21.0	400	44.4	45.2	+ 0.8	36.1	— 8.3
18.0	400	33.3	45.2	+11.9	36.1	+ 2.8
8.0	400	40.0	45.2	+ 5.2	36.1	— 3.9
21.3	394	39.4	44.9	+ 5.5	35.8	— 2.6
14.8	394	49.2	44.9	— 4.3	35.8	—13.4
32.0	380	43.6	44.1	+ 0.5	35.2	— 8.4
25.0	375	50.0	43.8	— 6.2	34.9	—15.1
33.6	374	49.9	43.7	— 6.2	34.9	—15.0
23.0	350	35.0	42.3	+ 7.3	33.7	— 1.3
16.0	350	38.9	42.3	+ 3.4	33.7	— 5.2
16.0	350	31.8	42.3	+10.5	33.7	+ 1.9
21.0	328	41.9	40.9	— 0.1	32.7	— 8.3
14.8	328	41.0	40.9	— 0.1	32.7	— 8.3
6.6	328	44.6	41.0	— 3.6	32.7	—11.9
18.0	318	42.4	40.3	— 2.1	32.2	—10.2
5.0	314	38.1	40.0	+ 1.9	31.9	— 6.2
8.2	305	39.4	39.5	+ 0.1	31.5	— 7.9
18.0	300	37.5	39.1	+ 1.6	31.2	— 6.3
15.0	300	33.3	39.1	+ 5.8	31.2	— 2.1
12.0	276	55.2	37.5	—17.7	30.9	—25.2
19.7	262	27.6	36.6	+ 9.0	29.2	+ 1.6
8.2	262	43.7	36.6	— 7.1	29.2	—14.5
5.0	261	33.9	36.5	+ 2.6	29.1	— 4.8
18.0	250	27.8	35.7	+ 7.9	28.5	+ 0.7
15.0	250	27.8	35.7	+ 7.9	28.5	+ 0.7
8.0	249	35.6	35.7	+ 0.1	28.5	— 7.1
10.5	209	31.2	32.7	+ 1.5	26.1	— 5.1
14.8	202	33.5	32.2	— 1.3	25.6	— 7.9
15.0	200	25.0	32.0	+ 7.0	25.5	+ 0.5
13.1	193	28.9	31.5	+ 2.6	25.1	— 3.8
8.0	191	31.3	31.2	— 0.1	24.9	— 6.4
11.1	180	32.7	30.3	— 2.4	24.2	— 8.5
8.0	171	22.8	29.6	+ 6.8	23.6	+ 0.8
11.0	167	24.6	29.2	+ 4.6	23.3	— 1.3
11.5	164	27.3	28.9	+ 1.6	23.1	— 4.2
2.6	162	31.2	28.8	— 2.4	23.0	— 8.2
14.0	160	26.7	28.6	+ 1.9	22.8	— 3.9
6.6	158	25.1	28.4	+ 3.3	22.7	— 2.4
15.0	150	21.4	27.7	+ 6.3	22.1	+ 0.7
11.5	148	21.1	27.5	+ 6.4	21.9	+ 0.8
9.8	148	26.4	27.5	+ 1.1	21.9	— 4.5

TABLE 1.—(*Continued.*)

Wave height. (1)	Wave length. (2)	WAVE VELOCITY, IN FEET PER SECOND.				
		Observed. (3)	Computed: $V=\sqrt{5.123\ L}$ (4)	Difference, columns (3) and (4) (5)	Computed: $V=1.804\sqrt{L}$ (6)	Difference, columns (3) and (6) (7)
4.6	148	29.8	27.5	— 2.3	21.9	— 7.9
8.2	145	26.9	27.3	+ 0.4	21.7	— 5.2
3.9	134	26.9	26.2	— 0.7	20.9	— 6.0
8.2	131	20.2	25.9	+ 5.7	20.6	+ 0.4
8.2	131	23.8	25.9	+ 2.1	20.6	— 3.2
7.5	131	21.7	25.9	+ 4.2	20.6	— 1.1
4.9	131	26.2	25.9	— 0.3	20.6	— 5.6
6.6	123	25.6	25.1	— 0.5	20.0	— 5.6
3.3	119	24.3	24.7	+ 0.4	19.7	— 4.6
8.9	115	19.2	24.2	+ 5.0	19.3	+ 0.1
7.5	115	19.2	24.2	+ 5.0	19.3	+ 0.1
4.6	115	24.0	24.2	+ 0.2	19.3	— 4.7
3.6	115	22.1	24.2	+ 2.1	19.3	— 2.8
2.6	108	23.6	23.5	— 0.1	18.7	— 4.9
8.0	100	14.3	22.6	+ 8.3	18.0	+ 3.7
7.0	100	16.7	22.6	+ 5.9	18.0	+ 1.3
6.0	100	16.7	22.6	+ 5.9	18.0	+ 1.3
4.0	100	12.5	22.6	+10.1	18.0	+ 5.5
6.6	98	16.3	22.4	+ 6.1	17.9	+ 1.6
4.9	98	21.8	22.4	+ 0.6	17.9	— 3.9
4.3	82	20.5	20.5	0.0	16.3	— 4.2
6.0	80	16.0	20.2	+ 4.2	16.1	+ 0.1
5.0	60	12.0	17.5	+ 5.5	14.0	+ 2.0
4.0	50	10.0	16.0	+ 6.0	12.8	+ 2.8
3.0	50	12.5	16.0	+ 3.5	12.8	+ 0.3
2.0	40	10.0	14.3	+ 4.3	11.4	+ 1.4
3.0	30	10.0	12.4	+ 2.4	9.9	— 0.1

The first five columns of Table 1 are taken from Table XI of Captain Gaillard's paper, and the last two columns were calculated by the writer. Captain Gaillard's observations were taken by eleven different sets of observers on forty-one different dates.

to flow and then shutting it off, the pendulum is started swinging; and, if the valve is opened while the pendulum is moving from left to right and closed for the rest of the time, the pendulum will keep up its swinging.

If the pendulum is well pivoted, the air as it strikes the ball will give it a little more force each time, causing it to swing higher and higher until it finally makes a complete circle, and as the air continues blowing on the ball it will go around faster and faster until the air current is just sufficient to overcome the friction.

Before the pendulum made the complete turn it kept fairly good time, considering the extra force given to it; but, after it made a complete turn, the time was reduced, and the number of revolutions depended on the air current.

When the air is shut off, the friction gradually reduces the time of revolution of the pendulum to that which would be swung by a pendulum of like arm, and then it ceases to turn completely over and keeps the same time until it stops altogether.

This action is similar to that of a water wave. The wind blowing on the crest of the wave, forcing it ahead and downward, causes the wave to travel faster than the velocity called for by the length; but by Formula 3, the velocity is dependent on the length of the wave; therefore, as the wave travels faster, it will try to lengthen out horizontally. This cannot be done immediately, as it is kept in place somewhat by the wave in front and the wave behind, so that the readjustment comes gradually. This adjustment may be accomplished by two waves uniting, one wave overtaking another, or as they run before the wind. If the wind should die out before the wave has readjusted itself it would still take some time to do so.

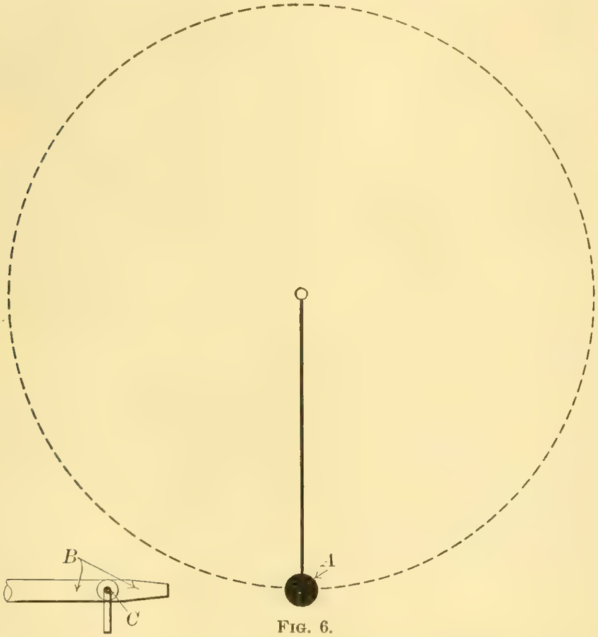


Fig. 6.

When the wave has readjusted itself and the wind has stopped blowing, the friction gradually causes the wave to travel more slowly, which reduces the wave length.

A study of Table 2 shows that the greatest percentage of increase of velocity occurs when the wind has been blowing for a comparatively short time; when the same wind velocity is maintained for a longer time the wave gradually lengthens out, which increases the theoretical velocity and reduces the percentage of increase.

TABLE 2.—INCREASE OF WAVE VELOCITIES ABOVE THE THEORETICAL, IN THE DULUTH CANAL, DUE TO THE WIND.

Date.	Length.	Mean depth.	MEAN WAVE VELOCITY, IN FEET PER SECOND.			HOURLY WIND VELOCITY, IN FEET PER SECOND.			Number of observations.
			Observed.	Computed.	Increase over theoretical.	During wave observations.	Maximum during 12 hours preceding.	Mean for 12 hours preceding.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1901.									
May 23...	180[a]	24.7-26.7	27.1	24.2	12%	48.2	80.7	57.5	39
June 14...	130	24.7-26.7	25.3	20.6	23%	49.1	55.9	29.6	20
September 24...	225[d]	24.7-26.7	27.7	27.0	03%	67.6	70.9	60.6	80
October 9...	145[b]	24.7-26.7	22.9	21.7	06%	42.2	49.1	28.6	30
November 6...	140[c]	24.7-26.7	28.7	21.4	34%	62.6	72.5	32.0	20
November 22...	150	24.7-26.7	25.3	22.2	13%	35.3	38.7	34.4	21
1902.									
August 15...	70	24.7-26.7	18.2	15.1	21%	29.0	31.8	18.0	3

[a] This length is the average of 160 and 200 ft.
[b] This length is the average of 140 and 150 ft.
[c] This length is the average of 130 and 150 ft.
[d] This length is the average of 200 and 250 ft.

The wind velocities in this table are the corrected velocities, as determined by the United States Weather Bureau by a Robinson's anemometer located on the edge of a high bluff in rear of the City of Duluth, and 1.25 miles from the point of observation of the waves, the wind blowing in the direction of wave travel.

Columns 1, 4, 7, 8, and 9 were taken from Table XIV of Captain Gaillard's paper.

Columns 2, 3, and 10 were taken from Table X of Captain Gaillard's paper.

Column 5 was computed by Formula 3.

Column 6 gives the percentage of increase over the theoretical velocity.

These seven observations were the only ones that could be used from Captain Gaillard's Table XIV, as the lengths of the other observations varied too much to get a fair average. Although these may be considered as shallow-water waves, they show very well the effect of the wind.

In Formula 3 the writer has only considered the horizontal length of the wave; but it is possible that the true length for finding the period of a wave should be taken along the surface or along the filament, *OP*, which passes through the center of gravity of the volume of water contained in *ABF*, Fig. 7. This would give the wave a longer period and slower velocity.

A study of Table 1 shows that most of the waves having a velocity slower than the theoretical are high waves; and, with waves of the same length, the highest are generally the slowest.

There are so many conditions that enter into the formation of a wave that the writer has not considered this refinement necessary, for, by using the horizontal length, the maximum theoretical velocity is obtained.

Depth to Which Wave Action Extends.—Fig. 7 shows regular waves, 100 ft. long and 10 ft. high, that portion between *M* and *K* being a complete wave. Now, it can be seen that the quantity of water included between *JK* is larger than that between *MJ,* by the water contained in *JIKL,* and this excess must pass by the vertical line through *J* twice in every complete wave motion; once forward with the wave, and once backward in the trough. It will also be seen that the quantity of water contained in *JIKL* must pass by any vertical line, as *NF,* twice in each wave motion.

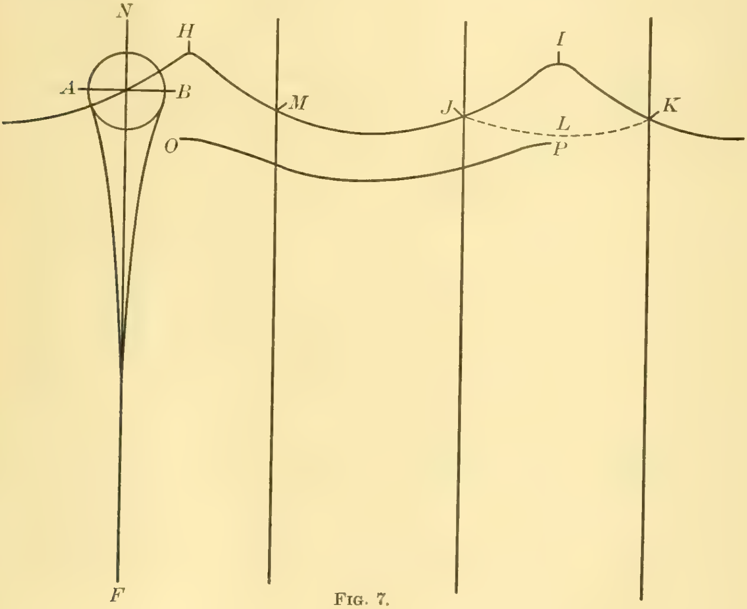


FIG. 7.

The motion of the particles of water on the surface is in a circle, with the height of the wave as the diameter. The motion below the surface decreases as the distance below the center of the surface orbits increases in arithmetical progression; the radii decrease in geometrical progression, this decrease being at such a rate that the area contained between the curved lines, *AF* and *BF,* joining the ends of the radii and perpendicular to them, is equal to the area, *JIKL.*

This gives a depth of wave action which is greater than is generally supposed. The depth could be decreased considerably without affecting the wave very much, as long as the changes are not so sudden that the wave could not readjust itself.

Shape of the Wave.—To plot the surface of a deep-water wave, lay off the length, *AB,* Fig. 8. Construct a circle tangent at *A,* with a diameter, *AC,* equal to the height of the wave. Divide *AB* into eight or as many equal parts as required, and erect perpendiculars. Divide the circumference of the circle into the same number of equal parts, and draw horizontal lines through these points. Let *A* be the lowest part of the wave. Next consider the particle, *M,* its center being one-eighth of the distance from *A* to *B.* It will be in the horizontal line drawn through *D*, and $\frac{A\,B}{8} + K\,D$ from *K*.

The particle, *N,* the center of which is one-fourth of the distance from *A* to *B,* will be in the horizontal line drawn through *F,* and $\frac{A\,B}{4} + E\,L$ from *L*. The particle, *O*, the center of which is three-eighths of the distance from *A* to *B,* will be in the horizontal line drawn through *F*, and will be $\frac{3\,A\,B}{8} + F H$ from *H*.

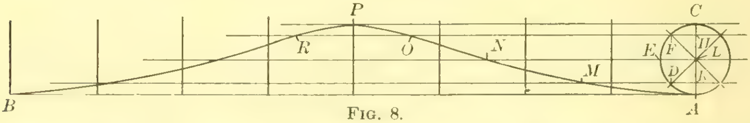


Fig. 8.

The particle, *P,* the center of which is one-half the distance from *A* to *B,* will be the top of the wave, and one-half the distance from *A* to *B.* The particle, *R,* the center of which is five-eighths of the distance from *A* to *B,* will be in the horizontal line drawn through *F,* and $\frac{5\,A\,B}{8} - F H$ from *H*. The rest of the wave should be plotted in a similar manner.

This surface wave is the same as that given by the trochoidal theory, but the writer prefers to consider it by his construction, as it is simple to understand.

It will be seen that the distance, *AM,* is greater than *MN,* and still greater than *NO,* showing that all the surface particles cannot have circles as their orbits; but that some of them must be forced under while others must be forced higher in the crest of the wave.

While this may not be the true shape of the wave, it is very close to it, and gives a quantity of water which is at least as much as that actually in the wave.

The shape of the wave at any point below the surface is shown in the same way, by using the same length of wave, but with a height corresponding to the diameter of the orbits at the depth taken.

All particles in a vertical line move in the same direction unless prevented by some outside action, such as the wind forcing the crest ahead, or friction on the bottom tending to retard the lower portion.

Height of the Wave.—The height of a wave is generally caused by the wind, and is modified by the depth of water and the "fetch," or open water from the windward shore. The wind, blowing unevenly on the water, causes the formation of depressions and ridges, after which the wind acts directly on the ridges or crests, forcing them ahead and downward. It has been seen that the back of the crest starts downward, and, with the added force of the wind, it goes a little deeper, and then, as it rises, it goes still higher than before.

The wind, causing the height, may also prevent the wave from going very high, as it may blow on the crest and force it to break or start downward before it has lost all upward motion.

It has also been stated that the height may have an influence on the period or velocity of the wave.

Wave Energy.—From Fig. 7 it is seen that the volume of water in the area, *JIKL*, moves forward and back in each complete wave, and that the same quantity must move forward in each wave crest. The volume contained in *JIKL*, considered as 1 ft. thick, may be approximately obtained by the formula:

$$O = \frac{L\,H}{4} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

In which L equals the length of wave, and H equals the height, both in feet.

This gives an energy of water moving forward with the wave, if taken 1 ft. wide, equal to the volume contained in the area, *JIKL*, multiplied by the velocity with which the wave is traveling, and may be found approximately by the formula:

$$\text{Energy} = \frac{V\,L\,h\,W}{4} \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

In which V = the velocity of the wave, in feet per second;
L = the length of the wave, in feet;
h = the height of the wave, in feet; and
W = the weight of a cubic foot of water, in pounds.

This does not mean that the same water moves forward with the wave, but it is the force in the moving wave.

The energy is distributed throughout the half of the wave at the crest, and downward to the greatest depth of wave action.

SHALLOW-WATER WAVES.

Waves moving in water of a depth less than one-half the wave length have generally been called shallow-water waves, because the friction on the bottom modifies somewhat their shape and velocity.

Waves may move in water which is much shallower than one-half the wave length without materially affecting their velocity. It can be seen that, of two waves of equal length, but with one having a height of twice the other, the larger wave, having about twice as much water moving forward, will feel the effect of friction on the bottom more quickly.

Velocity.—It is the writer's opinion that Formula 3 may be used for all waves with a coefficient suitable for the conditions. The theoretical velocity has been shown and also the increase in velocity due to wind action in a few cases. The first effect on deep-water waves running in on a beach is to reduce the velocity. The wind causes the waves to travel faster, so that they have to lengthen out, while the friction on the bottom causes the wave to travel more slowly, which shortens the wave lengths, as will be shown later.

A study of Table 3 shows in general that when the wave height is more than one-half of the depth of water, the velocity is materially reduced below the theoretical; but, when the wave height is less than one-half the depth, the observed velocity is as great as the theoretical.

When the wave height is from one-half to one-third of the depth of water, it is probable that the velocity begins to be materially reduced, and if the water continues to grow more shallow, the velocity and wave length are reduced until the wave breaks.

On Fig. 9 has been plotted the observed lengths of the waves, showing the percentage of the theoretical velocities; and a curve has been drawn through the averages, to give the percentage for any length under similar conditions.

TABLE 3.—HEIGHT, LENGTH, AND PERIOD OF WAVES OBSERVED IN THE DULUTH SHIP CANAL AND IN LAKE SUPERIOR, ARRANGED ACCORDING TO MEAN DEPTH OF WATER.

Date.	Heights, in feet.	Lengths, in feet.	PERIODS:		Mean depth, in feet.	Number of observations.
			Observed, in seconds.	Computed, in seconds.		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
OBSERVATIONS TAKEN IN DULUTH SHIP CANAL.						
1901.						
May 23	8.0–17.0	160–200	6.9–8.0	7.0–7.8	24.7–26.7	39
May 24	6.5– 8.0	130–150	6.0–7.5	6.3–6.8	24.7–26.7	3
June 14	9.0–12.0	130	5.1–5.8	6.3	24.7–26.7	20
June 15	2.0– 8.0	120–140	5.9–6.4	6.1–6.6	24.7–26.7	21
July 24	4.0–12.0	110–150	5.8–6.8	5.8–6.8	24.7–26.7	40
August 9	4.0–14.0	100–130	4.4–6.8	5.5–6.3	24.7–26.7	49
September 24	6.0–23.0	200–250	7.4–8.0	7.8–8.8	24.7–26.7	80
October 9	5.0–10.0	140–150	6.3–6.5	6.6–6.8	24.7–26.7	30
October 10	4.0– 9.0	150	6.8–8.3	6.8	24.7–26.7	20
November 6	6.0–13.0	130–150	4.9–5.4	6.3–6.8	24.7–26.7	20
November 22	7.0–16.0	150	5.5–6.4	6.8	24.7–26.7	21
1902.						
April 21	7.0–14.0	100–200	5.1–8.7	5.5–7.8	24.7–26.7	75
April 22	7.0–13.5	175–275	6.0–9.1	7.3–9.2	24.7–26.7	22
May 1	6.5–11.7	100–150	4.4–6.0	5.5–6.8	24.7–26.7	15
May 20	8.0–14.5	110–200	5.5–8.0	5.8–7.8	24.7–26.7	13
August 15	2.5	70	3.9	4.6	24.7–26.7	3
October 23	7.0–13.0	130–200	5.0–8.0	6.3–7.8	24.7–26.7	14
October 25	9.0–13.0	105–185	5.0–7.0	5.7–7.5	24.7–26.7	14
October 26	8.0–10.0	170–200	6.2–6.8	7.2–7.8	24.7–26.7	3
November 12	12.0–16.0	160–250	6.1–9.2	7.0–8.8	24.7–26.7	23
November 13	10.0–14.0	188–200	7.5–8.0	7.6–7.8	24.7–26.7	5
OBSERVATIONS TAKEN IN LAKE SUPERIOR.						
April 22	7.0–12.0	160–185	7.4–8.6	7.0–7.5	18.7	7
April 21	7.0– 9.7	150–184	6.9–8.0	6.8–7.5	15.7–15.9	4
May 20	4.0–13.0	140–187	7.5–9.0	6.6–7.6	15.7–15.9	26
April 22	4.0–10.0	140–180	6.7–8.7	6.6–7.4	13.0–14.0	14
September 13	7.5	120	6.0	6.1	13.0–14.0	3
October 23	5.0–10.0	89–164	5.5–9.6	5.2–7.1	13.0–14.0	15
October 25	6.0–10.0	94–134	4.5–7.1	5.2–6.6	13.0–14.0	9
June 5	2.5– 4.0	68– 73	3.9–6.5	4.6–4.7	6.9– 7.0	9
April 26	3.5– 4.5	75– 90	5.0–5.6	4.8–5.3	6.3	5
April 23	3.0	75	5.8	4.8	5.1– 5.7	3
June 4	3.0	50	4.0	3.9	5.1– 5.7	2
June 5	2.5– 3.5	50– 70	3.8–5.8	3.9–4.6	5.1– 5.7	10
April 23	2.5– 2.75	60– 70	5.4–6.2	4.3–4.6	4.0– 4.2	4
May 31	2.5	60	4.8	4.3	4.0– 4.2	2
May 31	2.0	45	4.9	3.7	3.3	4
June 3	2.5	50	4.8	3.9	3.3	3

Columns 1, 2, 3, 4, 6, and 7 were taken from Table X of Captain Gaillard's paper. Column 5 was calculated by Formula 2.

A study of the percentage of theoretical velocities in Table 4 shows that the smaller waves, containing less water, may travel with a smaller percentage before breaking.

The action of a deep-water wave passing into water of a gradually decreasing depth is as follows: As the wave enters shallow water, its

TABLE 4.—VELOCITY OF WAVES IN SHALLOW WATER IMMEDIATELY BEFORE BREAKING, NORTH BEACH, ST. AUGUSTINE, FLA., 1890-91.

Wave height. (1)	Wave length. (2)	WAVE VELOCITY, IN FEET PER SECOND: Observed. (3)	WAVE VELOCITY, IN FEET PER SECOND: Computed. $V = 1.804\sqrt{L}$ (4)	$\frac{\text{Observed}}{\text{Computed}}$ = Percentage of Theoretical. (5)	Number of observations. (6)
Inches.	Feet.				
2	2.0	1.7	2.6	65	2
3	4.0	2.3	3.6	64	2
4	6.0	2.5	4.4	57	2
6	10.0	2.8	5.7	49	4
8	14.0	4.0	6.7	62	2
10	20.0	5.0	8.4	62	2
Feet.					
1.0	23.0	5.4	8.7	62	5
1.25	27.0	6.8	9.4	72	5
1.5	30.0	7.0	9.9	71	3
1.7	35.0	8.0	10.7	75	1
2.0	46.0	8.4	12.0	69	4
2.25	50.0	9.4	12.8	73	4
2.5	60.0	9.4	14.0	67	10
2.75	70.0	10.3	15.1	68	5
3.0	75.0	11.7	15.6	75	6
4.0	82.0	12.2	16.3	75	10
4.25	85.0	13.0	16.7	78	2
4.5	90.0	14.0	17.1	82	4
5.0	120.0	15.2	19.8	77	8
6.0	150.0	18.2	22.1	82	2
7.0	160.0	21.5	22.8	94	1

Columns 1, 2, 3, and 6 were taken from the table on pages 99 and 100 of Captain Gaillard's paper. Columns 4 and 5 were calculated by the writer. North Beach has a uniform slope of about 1 : 100. These observations were made during calm weather, or only when a moderate wind prevailed, with the idea of eliminating any possible effect of wind.

lower part, flowing over the bottom, is retarded by friction, and tends to delay the upper part. This reduction of velocity produces several other changes:

First.—Waves coming in from deep water must have the same period from crest to crest, and, as the velocity is reduced, the distance between the waves is shortened.

Second.—By Formula 2, the period is dependent on the length, and, as the period is the same, there will be a tendency to maintain the same length. While these two changes act against each other, it is probable that the lengths vary more directly with the first case, in the following proportion:

$$\frac{\text{Original velocity}}{\text{Original length}} :: \frac{\text{New velocity}}{\text{New length}} \quad \ldots\ldots\ldots\ldots\ldots (7)$$

Third.—From Fig. 7 it is seen that the same quantity of water is carried along with the wave, and, if the wave length is shortened, then the height will have to increase, in order to contain the same volume of water. There will be a little loss in the size of the wave, due to the friction.

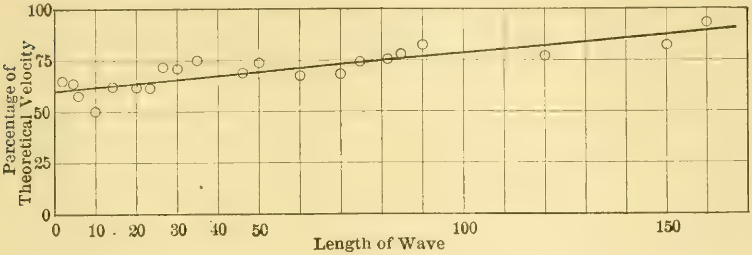


FIG. 9.

As the wave continues to advance, the velocity and length decrease, while the height increases. The friction on the bottom retards the motion of the lower layers, so that they are behind the upper layers in rotating, as is shown in Fig. 10. While the crest is moving forward, the lower layers are still moving forward and upward, so that the front of the wave is fairly steep, while the back is somewhat rounded. This action continues to increase until the crest becomes so unbalanced that it falls forward and breaks. The breaking of the wave is also assisted by the undertow, which reduces the available height of water and increases the friction of the lower part of the wave.

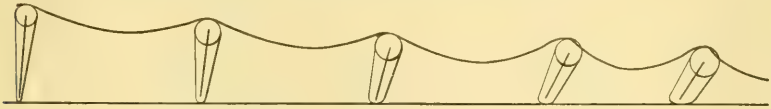


FIG. 10.

Captain Gaillard says:

"With a gentle slope of the bottom, or an opposed wind, [the height of the wave] was increased; while with a steeper slope, or with a wind in the direction of wave travel, [the height] was decreased."

This may be accounted for by the fact that with a gentle slope the wave has a chance to readjust itself to the new conditions and can become higher without breaking. The opposed wind has the effect of retarding the surface of the wave, thereby giving the lower layer a chance to keep up with the surface. With a steeper slope the wave does not have time to adjust itself, and therefore breaks. The wind traveling in the same direction partly causes the surface layers to move faster and partly blows the crest over.

Captain Gaillard makes the following statement:*

"Observations taken in the outer end of the Duluth Canal, August 9, 1901, when there was no current, showed that the maximum waves had a height of 12 feet. Similar observations at the same locality, taken half an hour later, when the velocity of the current opposed to the waves was about 2 feet per second, showed that the maximum waves were 14 feet high. The wind conditions were practically the same in both cases."

This may be explained as follows: These waves were formed in the lake, where there was no current; on approaching the entrance they met the current from the canal, and as the waves entered the canal the current was flowing out at about 2 ft. per sec. The waves were traveling at a certain velocity or period, and as they met the opposing current they still traveled at the same speed through the water; but, as the water was flowing to meet them, the waves gradually closed up until their length had been reduced by a number of feet equal to the product of the velocity of the flowing water and the wave period.

Formula 5 gives the approximate volume of water which is continually traveling forward with the wave, and, as the length is shortened, the height must be increased to contain the same volume of water.

In the observations under date of August 9th, 1901, in Captain Gaillard's Table X, the longest observed wave length and period will be examined, in order to see the result when moving into flowing water. The wave length is 130 ft., with a period of 6.8 sec., and the height will be considered as 12 ft. When this wave runs into an opposing current of 2 ft. per sec., the wave in rear will be nearer the wave in front by 6.8 times 2, or 13.6 ft., which reduces the length between crests to 116.4 ft.

By Formula 5, the volume of water moving forward with the wave in the lake will be approximately $\frac{130 \times 12}{4}$, while, with the wave traveling in flowing water there must be about the same volume, or $\frac{130 \times 12}{4} = \frac{116.4\, x\, y}{4}$; in which y equals the required height, or 13.4 ft. As this calculation is only approximate, and the observations were taken half an hour apart, it cannot be expected that they will be exactly the same.

---

* On page 83 of his paper.

Waves running into a current flowing in the same direction would be reduced in height; while waves formed in flowing water and running into still water would have their height increased or decreased, according to whether the current was flowing with or against them.

The cause of the increase of the height of the wave is the same, whether the wave travels into water with a gradually decreasing depth, or if the bottom is level with converging sides. This action is also illustrated by the tidal wave in the Bay of Fundy and the British Channel.

Waves traveling through a narrow opening into a large bay or harbor are greatly reduced in height in the bay. This can be accounted for by the fact that a wave in the harbor cannot contain more water moving forward than the same wave had when passing through the opening.

The height of the wave in the harbor may in general be calculated by the inverse ratio of its length along the crest to the length when passing through the opening, as follows:

$$\frac{\text{Height in harbor}}{\text{Length on crest in opening}} :: \frac{\text{Height in opening}}{\text{Length on crest in harbor}} \ldots\ldots (8)$$

Due allowance should be made for the shape of the harbor and causes tending to use up the force of the wave. The highest part of the crest will be in a line passing through the opening and extending in the direction of wave travel; while the crest on each side decreases with an increase of the

$$\frac{\text{Distance from the line of highest crest}}{\text{Distance of wave travel from the opening}}.$$

FORCE EXERTED BY WAVES.

The forces exerted by waves may be classed as follows:

(*1st*) That due to the onward motion of the water in the wave; this may vary from zero to that caused by action similar to water hammer;

(*2d*) That due to static pressure caused by a column of water, or by turning the direction of the moving water upward;

(*3d*) That due to the receding of the wave; this may vary from zero to that caused by a column of water standing at a height equal to $\frac{v^2}{2g}$, in which v is the velocity of the wave and g is the acceleration due to gravity;

(*4th*) That caused by floating objects on the water, as cakes of ice or logs, which may be hurled by the waves against any barrier.

1st. Force Due to Onward Motion of the Water.—It is probable that the full force of water hammer is never realized, and the nearest approach to such action would be when the water may rush into some opening in a wall or other structure which has an opening large enough to permit the air to escape, but is not large enough to take care of much water. If there is no escape for the air, it will be compressed until such time as the flow of the water is stopped and recedes to its normal state.

When the water is confined and there is a sudden stoppage of the flowing water, it exerts a pressure in all directions; but when the water is free, as in a wave, the force is nearly all in the direction in which the water is moving. This direction of water travel is the most important consideration of the forces in the wave.

In the case of a pile placed by itself in water, the force of a wave acting against it at any depth would be that caused by the velocity of the water, and would depend on the shape of the pile in allowing the water to flow past it. This same condition would hold true for the ends of a pier or other structure not broad enough to make a complete stop to the wave. In the case of a wall or breakwater which completely stops the passage of the wave, entirely different conditions obtain.

Fig. 11 represents a wall, *ABCD,* with a vertical face, the depth in front of the wall being such that the wave does not break. The distance, *KL,* is the height of the waves as they approach the wall, while *EF* is the limits of the highest and lowest part of the surface of the wave against the wall, and may be twice as much as *KL*.

It can be seen from the figure that the wall below *F* is always submerged, so that the water cannot be moving in a direction against the wall, and there will never be any force of a kinetic nature directly against it below this point.

The rise of the water against the wall, from *F* to *H,* is mostly by displacement, and, being in a vertical direction, the wave exerts hardly any force against the wall between these limits.

From *H* toward *E* there begins to be some horizontal motion against the wall, and this increases in force until the maximum is reached, at which point there is the greatest horizontal motion, together with a sufficient quantity of water, and from there to the top of the wave the force decreases as the quantity of water becomes less.

In deep water there will not be a very high force against a wall of this form, as the water next to it, in moving upward, deflects somewhat that which is moving horizontally.

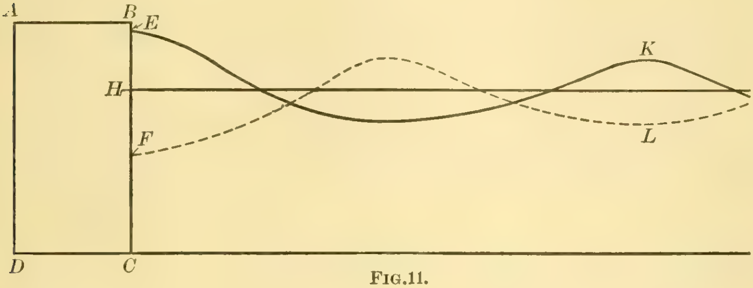


FIG. 11.

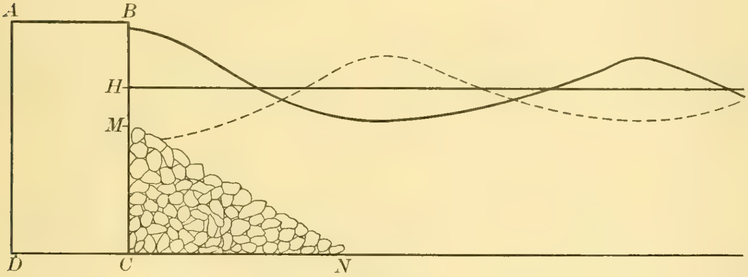


FIG. 12.

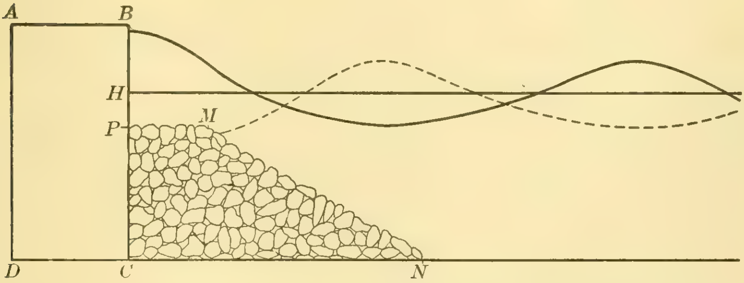


FIG 13.

Fig. 12 shows the same wall, but with a slope of rip-rap in front of it, as shown by *MNC*.

Formula 5 gives the approximate quantity of water moving forward with the wave, and in Fig. 11 this moving water is distributed down to the bottom and travels nearly up to the wall, where the force is lost by raising the water above its normal level.

In Fig. 12 the same quantity of water is traveling forward with the wave; but, on reaching the top of the rip-rap, the vertical height through which the wave passes is reduced, and, as it nears the wall, the moving water is concentrated into a comparatively small depth, and rushes forward and a little upward with great force against the face of the wall.

In Fig. 13 are shown the same conditions as in Fig. 12, but with a berm, *MP*. In this case, as the wave reaches the top of the slope, it looses its upward motion, and rushing forward strikes the wall square on the face.

In general, when the water in motion is concentrated into a small space, the force is also concentrated and the wave strikes with much greater power. When the face of the wall is perpendicular to the direction of water travel, it has to withstand a great force, but the reduction of the wave will be greater. When the wall is at an angle to the direction of water travel, it does not have to stand as much force, for the wave is partly deflected, to be broken up farther on.

In Figs. 12 and 13 the wave will break while on the rip-rap, causing the water to rush forward with great force.

The wave, breaking just before it reaches the wall, exerts the greatest force against it, consisting of the wave striking the wall and of changing the direction of the moving water from a horizontal to an upward one. When the wave breaks on the beach, there is the same horizontal action as in the previous case, but the water is allowed to travel onward, and spends its force on the beach.

2d. Force Due to Static Pressure.—First, there is the pressure due to the height of the water, and, second, the pressure caused by deflecting the water upward. The most important static pressure is that caused by deflecting the moving water. As the water, in moving forward horizontally, strikes the wall, its motion is not stopped, but continues in any direction that it may go. When the wave strikes the wall, it tries to go in all directions parallel to its face, and so exerts a pressure downward and against the wall. This pressure must be sufficient to cause the water to move upward, as this is the only direction in which it can go.

These two forces, kinetic and static, give pressures independent of each other, but are united into a greater pressure wherever they act at the same place.

The first, or kinetic pressure, may be found with a spring dynamometer, while the total pressure at any point of both the kinetic and static forces may be found with a diaphragm dynamometer. For the purpose of illustrating the pressure registered by these two types, Table 5 from Table XVIII, and Table 6 from Table XXI, of Captain Gaillard's paper are here given.

TABLE 5.—OBSERVATIONS WITH SPRING DYNAMOMETERS ON LAKE SUPERIOR, 1901-1903; OUTER END OF SOUTH PIERS, DULUTH CANAL AND SUPERIOR ENTRY.

Date.	Stage of lake above low-water datum, in feet.	OBSERVED MAXIMUM WAVE DIMENSIONS:			CORRESPONDING MAXIMUM DYNAMOMETER READINGS. PRESSURE, IN POUNDS PER SQUARE FOOT:			
		Height, in feet.	Length, in feet.	Velocity, in feet per second.	End of south pier, Duluth Canal. Elevation above low-water datum at which dynamometers were set:			South pier, Superior Entry.
					"C" +0.07 ft.	"F" +3.74 ft.	"A" +7.01 ft.	"E" +3.74 ft.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1901.								
July 24th	+1.7	12	150	24.2	250	1 150	1 030	Not set.
August 9th	+1.9	12	130	24.2	370	1 075	780	1 190
September 24th..	+1.9	16	250	33.2	1 630	1 930	2 050	2 255
								"D"
October 9th	+1.7	10	150	23.7	000	000	500	1 210
November 6th...	+1.9	13	150	29.6	000	1 275	1 260	1 615
November 22d...	+1.4	14	150	27.2	000	1 010	1 605	1 605
					"C"	"E"	"G"	
1902.					+7.04 ft.	+12.57 ft.	+16.18 ft.	Removed.
October 23d	+1.5	13	200	30.0	800	445	000	Removed.
October 25th	+1.7	16	200	30.0	1 755	1 335	000	Removed.
November 12th..	+1.7	18	250	32.0	2 370	2 195	1 370	Removed.
December 20th..	+1.7	16	210	31.0	1 700	1 430	515	Removed.

It will be seen that the spring dynamometer, "C," when set from 1.3 to 1.8 ft. below the general level of the water gave readings only on 3 out of 6 days, and registered the kinetic energy of the wave; while the diaphragm dynamometer, No. 2, when set from 0.6 to 1.1 ft. below the general level of the water gave many readings on each day, while the observations were being taken, and registered the total force of the wave against the dynamometer.

TABLE 6.—OBSERVATIONS WITH DIAPHRAGM DYNAMOMETERS AT OUTER END OF SOUTH PIER, DULUTH SHIP CANAL.

Date. (1)	Stage of water above low-water datum, in feet. (2)	Period occupied in observing, in minutes. (3)	MAXIMUM CORRESPONDING WAVE DIMENSIONS:			PRINCIPAL SYNCHRONOUS DYNAMOMETER READINGS. PRESSURE, IN POUNDS PER SQUARE FOOT.		Total number of readings recorded. (9)
			Height in feet. (4)	Length, in feet. (5)	Velocity, in feet per second. (6)	Dyn. 2. (7)	Dyn. 1. (8)	
1902.								
June 17........	+1.2	25	4.8	50	16.0	410	000	26
“ 17........	....	..	....	...	....	385	000	...
July 2........	+1.3	38	5.0	50	16.0	531	000	16
“ 2........	....	..	....	...	....	485	000	...
“ 3........	+1.2	62	5.0	70	19.0	677	000	30
“ 3........	....	..	....	...	....	677	000	...
August 18........	+1.6	91	6.0	90	21.3	864	....	79
“ 18........	....	..	....	...	....	864	000	...
“ 18........	....	..	....	...	....	792	50	...
“ 18........	....	..	....	...	....	720	....	...
“ 18........	....	..	....	...	....	720	110	...
“ 18........	....	..	....	...	....	648	000	...
“ 18........	....	..	....	...	....	331	166	...
“ 18........	....	..	....	...	....	315	166	...
“ 18........	....	..	....	...	....	364	149	...
October 23........	+1.5	81	10.0	150	25.0	965	....	232
“ 23........	....	..	....	...	....	821	....	...
“ 23........	....	..	....	...	....	821	202	...
“ 23........	....	..	....	...	....	821	000	...
“ 23........	....	..	....	...	....	821	58	...
“ 23........	....	..	....	...	....	677	101	...
“ 23........	....	..	....	...	....	677	58	...
“ 23........	....	..	....	...	....	677	22	...
“ 23........	....	..	....	...	....	677	130	...
“ 23........	....	..	....	...	....	461	1 210	...
“ 23........	....	..	....	...	....	461	778	...
“ 25........	+1.7	63	13.0	200	30.0	965	230	118
“ 25........	....	..	....	...	....	965	000	...
“ 25........	....	..	....	...	....	821	144	...
“ 25........	....	..	....	...	....	677	(*a*)	...
“ 25........	....	..	....	...	....	677	302	...
“ 25........	....	..	....	...	....	677	230	...
“ 25........	....	..	....	...	....	677	000	...
“ 25........	....	..	....	...	....	504	634	...
“ 25........	....	..	....	...	....	389	634	...
“ 25........	....	..	....	...	....	353	(*a*)	...
“ 25........	....	..	....	...	....	317	(*a*)	...
“ 25........	....	..	....	...	....	....	1 642	...
“ 25........	....	..	....	...	....	....	634	...
Total........	......	360	......	......	......	......	......	561

(*a*) The movement of the index hand of the gauge was so rapid for these three observations that the observer could not follow it with his eye quickly enough to secure accurate readings, but was of the impression that in each of these cases it corresponded to as much as 20 lb. per sq. in., or, after correction for index error, 2 794 lb. per sq. ft. He was of the impression that the movement of the index hand in these cases was so rapid that it probably passed beyond its true position. For these reasons, and until further experiments can be made to determine this point, it has been considered best not to include them in the preceding table.

The formula commonly used for calculations of the theoretical force of flowing water against a plate which is set in the current and normal to it, is:

$$P = f \frac{w}{2\,g} A\,v^2$$

In which P denotes the pressure, in pounds;

f = a coefficient to be determined;
w = the weight of a cubic foot of water, in pounds;
g = the acceleration due to gravity, in feet per second;
v = the velocity of the current, in feet per second; and
A = the area of the plate, in square feet.

Captain Gaillard has used $(v + v'')^2$ in place of v^2, in which v equals the velocity of the wave and v'' the velocity of the particles of water in their orbits, and he has determined a constant from the results of his tests to be used as f.

While the writer agrees that the velocity of the wave should be used and that the velocity may be increased by v'', he also thinks that the velocity may be much greater than $v + v''$, and that the static pressure should be considered, therefore he prefers to use only the velocity of the wave and to have a varying coefficient, as f, to suit the conditions.

Tables 7, 8, 9, and 10 are here given, and an effort will be made to show why the Formula, $P = f \frac{w}{2\,g} A\ v^2$, is used.

Columns 1, 2, 3, 4, 5, 6, 8, 9, and 11 of Tables 7 and 8 are taken from Table XXII, Sections I and II, of Captain Gaillard's paper. Column 9 is found by the formula, $P = f \frac{w}{2\,g} A\ (v + v'')^2$, and using the average of Column 6, or 1.31, for the value of f. Columns 7 and 10 were calculated by the writer, and substituting in Table 7 the mean value of f, or 2.32, in the 7th column for the coefficient in the 10th column. In Table 8 the coefficient for use in the 10th column was determined by using the mean of f, or 2.00, as found in the 7th column of this table and of Table 9.

Table 10 is from Captain Gaillard's Table XIX. The observations of Table 7 were taken on the beach, and the dynamometers were placed in position so that the wave had broken before reaching them. The observations of Tables 8 and 9 were taken from the same place, on the outer end of the south pier, Duluth Canal, the water being about 24 ft. deep in front of the pier.

A study of these tables will show that when the waves break on the beach, the water being contracted into a lesser depth, the coefficient is 2.32. At the outer end of the south pier, with 24 ft. of water, it is probable that the wave does not have a chance to break with as much force in comparison to its size as when on the beach, because of the depth and the distribution of the moving water down to the bottom. The average coefficient in this case is 2.00. Substituting $(v + v'')^2$ for v^2 in these two cases gives for the coefficients values of 1.32 and 1.21, respectively, which shows there must be a difference in the conditions.

In both of these cases the wave was not completely stopped, but flowed around the dynamometer and kept on its way. When a wave strikes a wall, its progress is stopped, and there will be a force against the wall caused by both the stopping and turning upward of the moving water.

TABLE 7.—COMPARISON OF OBSERVED AND COMPUTED MAXIMUM READINGS OF SPRING DYNAMOMETERS.

North Beach Street, St. Augustine, Fla., 1890-91.

MAXIMUM WAVE DIMENSIONS:							MAXIMUM DYNAMOMETER READINGS. PRESSURE, IN POUNDS PER SQUARE FOOT.			
Height, in feet. (1)	Length, in feet. (2)	Velocity, in feet per second. (3)	v'' (computed) in feet per second. (4)	$(v + v'')^2$ (5)	$= \frac{2gP}{w(v+v'')^2}$ (6)	$f' = \frac{2gP}{wv^2}$ (7)	Observed, in pounds. (8)	Computed, $P = 1.31 \frac{w}{2g} A (v+v'')^2$ in pounds. (9)	Computed, $P = 2.32 \frac{w}{2g} v^2$ in pounds. (10)	Number of observations.
2.0	46	8.4	2.9	127.7	1.16	2.08	148	168	160	1
2.5	60	9.4	3.2	158.8	1.45	2.61	230	209	191	12
2.75	70	10.3	3.5	190.4	1.41	2.51	269	249	240	5
3.0	75	11.7	3.7	237.2	1.36	2.35	322	310	310	20
3.5	78	12.0	4.0	256.0	1.22	2.17	313	335	325	8
4.0	82	12.2	4.1	265.7	1.53	2.55	406	348	359	20
4.5	90	14.0	4.9	357.2	1.27	2.31	452	469	443	15
5.0	120	15.2	5.3	420.2	1.11	2.02	467	550	522	16
5.5	130	16.7	5.7	501.8	1.10	1.97	550	657	631	3
6.0	150	18.2	6.2	595.4	1.12	2.01	667	780	748	7
Total.	....	....	....	......	....	....	....	....	....	107
Mean..	....	....	....	......	1.32	2.32	....	...	....	....

TABLE 8.—Comparison of Observed and Computed Maximum Readings of Spring Dynamometers.

Duluth Canal and Superior Entry, Lake Superior, 1901-02.

Maximum wave dimensions:							Maximum dynamometer readings. Pressure, in pounds per square foot.			
Height, in feet. (1)	Length, in feet. (2)	Velocity, in feet per second. (3)	v'' (computed), in feet per second. (4)	$(v + v'')^2$ (5)	$f = \frac{2\,g\,P}{(v + v'')^2}$ (6)	$f' = \frac{2\,g\,P}{w\,v^2}$ (7)	Observed, in pounds. (8)	Computed, $P = 1.31\,\frac{w}{2\,g}\,A\,(v + v'')^2$ in pounds. (9)	Computed, $P = 2.00\,\frac{w}{2\,g}\,A\,v^2$ in pounds. (10)	Number of observations. (11)
12.0	150	24.2	7.3	992.2	1.20	2.02	1 150	1 259	1 138	1
12.0	130	24.2	7.9	1 030.4	1.20	2.09	1 190	1 307	1 138	1
16.0	250	33.2	10.6	1 918.4	1.22	2.11	2 255	2 432	2 138	1
10.0	150	23.7	6.0	882.1	1.41	2.22	1 210	1 118	1 090	1
13.0	150	29.6	9.8	1 552.4	1.07	1.90	1 615	1 968	1 700	1
14.0	150	27.2	9.6	1 354.2	1.23	2.24	1 605	1 718	1 434	1
16.0	200	30.0	10.3	1 624.1	1.12	2.01	1 755	2 059	1 746	1
18.0	250	32.0	11.5	1 892.2	1.29	2.39	2 370	2 400	1 986	1
16.0	210	31.0	10.4	1 714.0	1.02	1.83	1 700	2 174	1 862	1
Total..	....	....	....	......	....	....	....	......	......	9
Mean..	....	....	....	......	1.20	2.09	....	......	......	..

The following is quoted from Captain Gaillard's paper,* and followed his Table XIX:

"It will be noticed that dynamometer *M*, measuring the vertical force, gave a reading for every storm, while *O* gave no reading whatever for 5 out of 10 storms. The largest single reading was due to vertical force, which was in excess of the horizontal in 6 out of 8 cases.

"It is to be regretted that it was not practicable to set the pressure plate of dynamometer *O* flush with the face of the sea wall. If this could have been done the results might have been different, for on several occasions masses of water were seen projected rapidly upward along the face of the sea wall, the layer of water apparently being not more than a foot or so in thickness measured perpendicularly to the wall. This mass of water would impinge upon the pressure plate of dynamometer *M*, squarely and with considerable force, but would apparently produce no effect on dynamometer *O*. It is quite possible that the effect of the vertical wall, only a foot in rear of the pressure plate of dynamometer *O*, might have been to cause a counter pressure on the rear of this plate so soon after wave impact against the front, that during some storms no compression could take place. For this reason the types of spring dynamometers heretofore used do not appear well adapted for use against an area of large extent, and of a form which tends to prevent water in rear of the pressure plate from moving freely away.

---

* Page 159.

"It would seem from what has been stated, that they may, as a result of counter pressure, give readings too *small,* but cannot give readings too *large.*

"The effect of this sea wall was to produce concentrated wave energy at times, and this could plainly be seen in the case of the upward vertical force.

"It is further shown by the fact that although the water just in front of the wall was never deeper than 5.2 feet, yet three dynamometer readings were obtained which were greater than the maximum reading at either the south pier of the Duluth Canal or at Superior Entry, and are on an average about four times greater than the maximum dynamometer reading for breaking waves of equal size at North Beach, Florida."

TABLE 9.—COMPARISON OF OBSERVED AND COMPUTED MAXIMUM READINGS OF DIAPHRAGM DYNAMOMETERS ON OUTER END OF SOUTH PIER, DULUTH CANAL, 1902.

MAXIMUM WAVE DIMENSIONS:			v'' (computed), in feet per second. (4)	$(v + v'')^2$ (5)	$f = \frac{2gP}{w(v+v'')^2}$ (6)	$f' = \frac{2gP}{wv^2}$ (7)	MAXIMUM DYNAMOMETER READINGS. PRESSURE PER SQUARE FOOT.		
Height, in feet. (1)	Length, in feet. (2)	Velocity, in feet per second. (3)					Observed, in pounds. (8)	Computed, $P = 1.31 \frac{w}{2g} A (v + v'')^2$ in pounds. (9)	Computed, $P = 2.00 \frac{w}{2g} A v^2$ in pounds. (10)
4.8	50	16.0	4.7	428.5	0.99	1.65	410	542	496
5.0	50	16.0	4.9	436.8	1.26	2.14	531	553	496
5.0	70	19.0	4.2	538.2	1.30	1.93	677	681	700
6.0	90	21.3	4.6	670.8	1.33	1.96	864	850	880
10.0	150	25.0	6.3	979.7	1.28	2.00	1 210	1 241	1 204
13.0	200	30.0	8.5	1 482.2	1.14	1.86	1 642	1 877	1 743
Mean..	....	....	....	....	1.22	1.92	....	....	....

Columns 1, 2, 3, 4, 5, 6, 8, and 9 were taken from the Table XXIII of Captain Gaillard's paper. Column 9 was computed in the same manner as Column 9 of the two previous tables. Columns 7 and 10 were calculated by the writer, the last being found as was Column 10 of Table 8.

From these tables and the remarks it can be seen that the value of the coefficient, *f*, will vary according to the conditions under which the wave is stopped.

TABLE 10.—OBSERVATIONS WITH SPRING DYNAMOMETERS FASTENED TO SEA WALL, SOUTH OF SOUTH PIER, DULUTH CANAL, LAKE SUPERIOR.

(Dynamometer *"O,"* face vertical. Dynamometer *"M,"* face horizontal.)

Date. (1)	Stage of lake above low-water datum, in feet. (2)	Depth at dynamometers on date given, in feet. (3)	Corresponding depths 200 ft. lakeward, in feet, "O." (4)	MAXIMUM DYNAMOMETER READINGS. PRESSURE, IN POUNDS PER SQUARE FOOT: "O" Elevation = +4.00 ft. (5)	"M" Elevation = +3.70 ft. (6)
1902.					
August 18	+1.6	5.1	6.6	1 100	Not set.
September 15	+1.3	4.8	6.3	000	610
" 20	+1.2	4.7	6.2	000	690
October 13	+1.0	4.5	6.0	000	655
" 16	+1.2	4.7	6.2	000	770
" 23	+1.5	5.0	6.5	2 430	2 725
" 25	+1.7	5.2	6.7	000	1 100
November 12	+1.7	5.2	6.2	1 160	790
December 6	+1.3	4.8	6.3	1 060	Not read.
" 20	+1.7	5.2	6.7	2 490	1 100

3d. Force Due to the Receding of the Wave.—In Fig. 7 it was shown that the same volume of water is carried forward with the wave and also backward in the trough.

A pile placed by itself in water will be subject to pressure from the forward movement of the wave and also the backward movement in the trough. These pressures will be nearly the same, except that one will be applied lower than the other.

If a pipe, 10 ft. high and having an area of 1 sq. ft., were closed at the lower end and filled with water, the pressure on the bottom would be about 625 lb. Then if the upper end were closed and the lower end released so that the water would be held up by the top end, the water would be exerting a pull downward of about 625 lb. If there was a sufficient supply of water, so that there would always be a head of 10 ft. on the lower end when both ends were open, and the lower end were closed with a plug having an area of 1 sq. ft., it would probably take a much greater pressure than 625 lb. to stop the flow. These conditions are similar to those in a sea wall which is exposed to wave action.

When the wave in its forward motion strikes the wall, there will be a force in excess of a pressure caused by a column of water of sufficient height to produce the velocity of the wave.

When the wave is receding, there is no horizontal motion next to the wall; but, if the wall were not there, the water would move with a velocity suitable to the conditions, and thus the wall holds the water from moving like the closed upper end of the pipe.

This suction or pull on the wall would be nearly equal to the weight of a column of water of a height sufficient to produce the velocity of the moving water. This pull would not be equal to the theoretical amount because, as the water cannot move directly from the wall, the general level of the water is lowered to make up the deficiency.

From Fig. 11 it can be seen that as the water is descending from *B* to *H* there will not be any pull on the wall on account of it being higher than the adjacent water. As the water drops below *H*, it begins to pull on the wall and probably reaches the maximum about half way from *H* to *F*, and then the pull decreases until the water reaches the lowest point, when it begins to rise again.

The best conditions occur when the wall is tight, so that no water can pass through; but if the wall is porous, as a rock-filled crib would be, then, in addition to the force already described, there would be forces caused by the pressure of water on the inside and the friction of the water moving through the crib.

If there is a slope of rip-rap in front of the wall, as in Fig. 11, then the receding water, being contracted into a much smaller space, will flow with a much greater velocity, and is likely to take some of the rip-rap along with it.

Vol. XXXVI. DECEMBER, 1910. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

THE FAILURE OF THE YUBA RIVER DÉBRIS BARRIER, AND THE EFFORTS MADE FOR ITS MAINTENANCE.

Discussion.*

By Messrs. William W. Harts and W. C. Hammatt.

Mr. Harts.

William W. Harts,† M. Am. Soc. C. E. (by letter).—This barrier was one of a series of extensive works adopted on the Yuba River for the purpose of holding back the débris which had been dislodged by hydraulic mining and was later filling the channels of the navigable streams during each flood. The original design for this control was prepared by the California Débris Commission before the writer's connection with it, and has been described by him.‡

After a number of unsuccessful attempts at dam construction in this locality, the writer was called on to design a barrier that would hold débris. There were several unusual conditions: First, the discharge of the river is variable, ordinarily extending from 600 or 700 sec-ft., and reaching 60 000 or 70 000 sec-ft., these higher stages lasting but a few days at a time. Second, the foundations were gravel and fine sand, intermixed with boulders, extending to great depths, on which any permanent structure would be built at considerable risk. Third, only a small portion of the total height could be built in any one season, as a portion when completed was necessarily subject to floods during the winter following, making the work of necessity one of successive steps, each of which would have to be completed in a

---

* This discussion (of the paper by H. H. Wadsworth, M. Am. Soc. C. E., published in *Proceedings* for September, 1910, and presented at the meeting of November 16th, 1910), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

† Major, Corps of Engineers, U. S. A.

‡ *Transactions*, Am. Soc. C. E., Vol. LVII, p. 1.

Mr. Harts.

single working season. Fourth, the cost could not be high, as the total amount available for the entire system was limited.

It occurred to the writer that the best solution would be to divert the river, during ordinary flow and in moderate floods, through a spillway which could be cut in the rock bank on the south side of the river, and construct in connection with it a rock-filled dam, held in place by piles and covered with a layer of concrete, so that the peak of the floods, usually of a few days' duration only, could be passed over the dam without more than slight injury, easily repaired each season. It seemed that in some such way only could a permanent dam be constructed at moderate cost at the site where required. If such a dam could be constructed strong enough in the first few steps so that the spillway need not be built until the structure had reached a considerable height, much spillway excavation in the rock could be saved. The plan adopted involved raising the dam to a height of about 22 ft., in three steps, the river flow to be carried through the rock spillway, which was to be large enough to accommodate 20 000 sec-ft., all water above this quantity passing over the crest of the dam. It was ascertained from the records that, with this spillway capacity, the dam would be used but a few days each season, the high-water wave being of short duration. In order to reduce the cost of construction, it was determined not to commence the spillway until two steps had been finished. The first step withstood successfully the high-water stages of several seasons, and the second step had likewise passed through two flood periods without particular injury. It was expected during construction that the usual floods would be encountered each winter, and the information as to the river stages was relied on to indicate their magnitude and duration. Although the construction was attended with some risk, it was not an unreasonable one. It appears to be beyond question that, but for the unprecedented flood occurring after the cessation of the ordinary high-water stages and after work for the next season had begun, the plan would have been satisfactory. This unprecedented flood, as has been stated by the author, set a new record for high water on the Sacramento and Feather Rivers, and created great destruction elsewhere in that vicinity. This flood has been very fully described.* The author's description of the method of failure appears to have been analyzed correctly, but it is impossible to do more than surmise as to which method of failure was the predominant one.

Owing to the shortage of funds and the necessity for completing other portions of the débris system first, it was decided not to restore this work until the more important features lower on the river had been completed.

As sometimes occurs in connection with structures of this kind, there arose some of those unprecedented and unforeseeable conditions which occasionally derange and at times upset the most carefully laid plans. Although reasonable risks can never be entirely avoided by the hydraulic engineer, the measure of how far he may trust known local conditions in building unusual structures is one that can only be regulated by personal judgment and experience. Mr. Harts.

---

* *Transactions*, Am. Soc. C. E., Vol. LXI, p. 281.

Mr. Hammatt. W. C. HAMMATT, M. AM. SOC. C. E. (by letter).—In reading this paper the writer was particularly impressed with the inefficacy of the attempts to protect the toe of the barrier against scour, due to the double cause of erosion from the overpour of the water and the flattening of the slope of the stretch below the barrier by the removal of débris from the bed. It is believed that this might have been prevented by a method which the writer has applied with good results to structures of various classes.

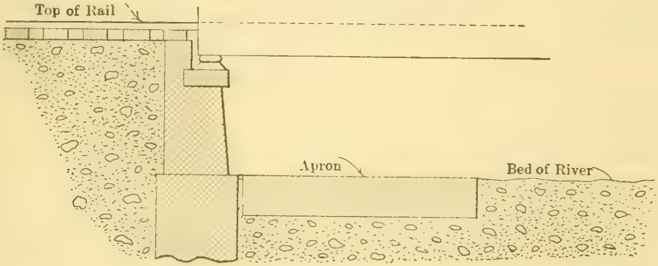


FIG. 2.

In 1897 the writer had occasion to protect the footing of a masonry bridge abutment erected without piling on a gravelly bed at a point where a sharp bend of the river made it especially subject to scour. He placed a concrete apron, 16 ft. wide and 3 ft. deep, in front of the whole exposed face of the abutment, the upper surface being level with the river bed. The apron was entirely detached from the foundation of the abutment, and was free to settle if there was any scour, as shown by Fig. 2. As will be readily seen, the apron will settle and stop the scour before it can reach the bridge abutment.

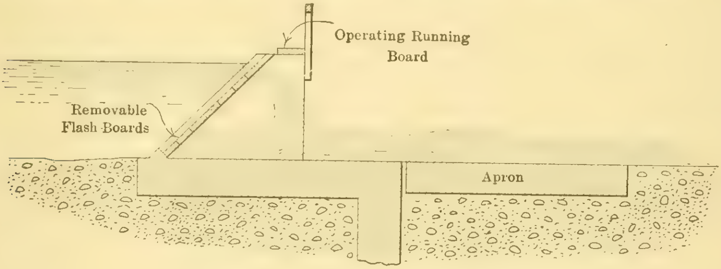


FIG. 3.

Mr. Hammatt.

This was so effective that the writer has subsequently used the same principle many times. He has found it very useful for weir dams in torrential streams, notably one in Los Baños Creek, Mercer County, California. In this case, however, the apron was constructed in sections, or slabs, 16 ft. wide, 10 ft. long (in the direction of the dam), and 12 in. thick, as shown by Fig. 3. These slabs were entirely free to move independently of each other, in order to take care of scour in small sections.

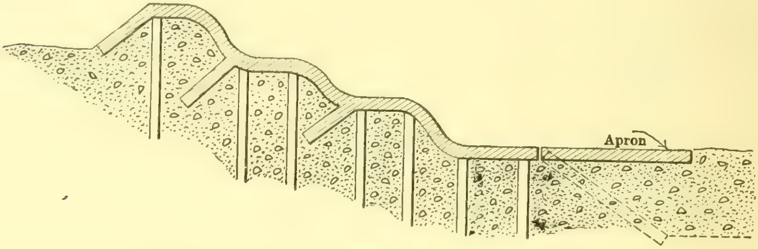


Fig. 4.

It is believed that an apron of the same general nature would have given ample protection to the Yuba River débris barrier and prevented its final failure. As erosion took place in the river bed below the barrier, the apron would drop gradually to the position shown by the dotted lines in Fig. 4. After it had reached an inclination which rendered it inadvisable to allow it to sink farther, a new protective apron could have been constructed on the lower level, which, in turn, would have taken up the slope if the scour continued, thus forming a continuous rip-rap in front of the structure.

Vol. XXXVI. DECEMBER, 1910. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

HYDROGRAPHY AS AN AID TO THE SUCCESSFUL OPERATION OF AN IRRIGATION SYSTEM.

Discussion.*

BY MESSRS. E. F. CHANDLER, C. E. SHIPMAN, CLEMENS HERSCHEL, AND ROBERT FOLLANSBEE.

Mr. Chandler.

E. F. CHANDLER, ASSOC. M. AM. SOC. C. E. (by letter).—This paper shows that systematic changes in rating tables may be caused by the growth of vegetation in canals during the "growing season." The frictional coefficient being thereby increased, the velocity is retarded, and, if the discharge remains constant, or even if it diminishes somewhat, the gauge height may increase from month to month. At the opening of the next season, after the channel has been cleaned by the winter frosts, or artificially, the flow is again more rapid at a lower gauge height.

In northern regions, in many natural streams of slight fall, where the spring run of ice carries away the vegetation, the same thing occurs. A very striking illustration of this has been taken from the records of a gauging station maintained for a time by the U. S. Geological Survey on the James River, at LaMoure, N. Dak. This river has a fall of much less than 1 ft. per mile, and, through a large part of the year, the discharge is so small as hardly to entitle it to the name of "creek," although its early spring flow is sometimes about 1 000 sec-ft. The weeds growing in the channel are locked in ice 2 ft. thick during the winter, and are torn loose when the ice rises in the spring, so that the stream begins the season with a comparatively clear channel.

---

*This discussion (of the paper by J. C. Stevens, Assoc. M. Am. Soc. C. E., published in *Proceedings* for November, 1910, and presented at the meeting of December 7th, 1910), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

Mr. Chandler. By placing the gauge zero near the bottom of the channel, the following discharge measurements were obtained:

May 8th, 1903, gauge height, 4.0 ft.; discharge, 127 sec-ft.

July 29th, 1903, gauge height, 5.2 ft.; discharge, about 10 sec-ft.

At such a station, although an abrupt change in gauge height would indicate change in discharge, the gradual change throughout the season is merely an indication of the luxuriance of the growth of vegetation. By frequent discharge measurements, there could have been determined, at short intervals, the values of a systematic correction to be applied to the gauge heights, as done by Mr. Stevens, but this would have added to the expense of maintaining the station an amount disproportionate to the value of the record at that point; hence, it is needless to explain that the station was discontinued on July 30th.

In river record work, it is usually unnecessary and inadvisable to locate permanent open-season gauging stations where such causes operate; hence corrections of this class have not been studied as thoroughly as their importance warrants, for in canal work this effect is often noticeable.

It may be remarked that this same method of applying systematic corrections to the gauge height, as deduced from frequent discharge measurements, is a convenient means often used for applying rating tables to gauge-height records during the winter, in Dakota, where the velocities are slow, and the ice is therefore usually fairly smooth on the lower surface, giving a fairly constant frictional resistance during the winter; but, where the ice becomes thick, its thickness and also the frictional resistance caused by it are very important factors to be considered in summarizing the flow.

Mr. Shipman. C. E. SHIPMAN, ASSOC. M. AM. SOC. C. E. (by letter).—The author mentions a matter which is exceedingly important, when he points out, as a "human problem," the tendency of most irrigators to take all the water they can get, even though their crops do not need it and their lands may be ruined thereby. The results of such a tendency are very well illustrated in the Yellowstone Valley near Billings, Mont. Some sections of this valley have been irrigated for 25 years or more. The principal crops are alfalfa, oats, and sugar beets. The Yellowstone River carries an abundant supply of water, the canals are of ample size, and except when, as during the latter part of 1910, the river falls below the head-gates, there is never any scarcity of water. The ranchers, therefore, have used, or attempted to use, twice or three times as much water as their crops required, and as a result, hundreds of acres which formerly produced two or three crops of alfalfa, now produce nothing but cattails and mosquitos, and are practically worthless.

Some attempt has been made to remedy these conditions by the construction of drains, under the provisions of a State Drain Law.

Mr. Shipman.

These are usually box-drains, placed far enough below the surface to tap the gravel which underlies the valley and carries a large quantity of water; they are generally from 5 to 10 ft. deep. These drains have been very successful, but their cost is enormous, in some cases equal to or exceeding the cost per acre of the irrigation system. The writer believes that if an attempt had been made to ascertain in some manner the quantity of water actually delivered to each irrigator, much of the trouble would have been eliminated; and he is of the opinion that much of the value of such data as the author has collected concerning the Sunnyside Canal, is in the opportunity afforded for detecting wasteful and excessive use of water.

Undoubtedly an irrigation canal should be "metered," and the water sold at so much per acre-foot. In too many cases, the method of measurement has been the "eye" of the ditch rider, assisted by a "Konnewock" of some description, and while he may have been able to divide the entire quantity of water flowing in the canal among the water users in proportion to their respective shares, it has not been shown that he did not give each user 50 or 100% more than his shares called for and his crops required.

The average land-owner would probably say that such methods as the author describes are too expensive, and that no one but the Government can afford to adopt them, but according to the cost data given in the paper, the cost for 1909 amounted to about 4½ cents per acre, certainly a very reasonable figure.

The writer notes that in Table 6, the losses from the main canal from seepage, etc., are given as 16.9%, which would indicate that the usual allowance (½% to 1% per mile) is excessive. The total loss in main canal and laterals combined, 32%, is almost exactly ½% per mile of main canal.

The writer believes that on the irrigation systems constructed and operated by the United States Reclamation Service a more intelligent effort has been made to determine the actual quantity of water used than has been customary on private projects, and that these private projects will find it necessary at no very distant date to adopt more accurate methods than they have used heretofore.

Mr. Herschel.

Clemens Herschel, M. Am. Soc. C. E. (by letter).—The writer will take for his text this sentence from Mr. Stevens' admirable paper:

> "The time is not far off when the water used on these large systems will be distributed as carefully as under the metered systems of large cities, where patrons pay only for the water they use."

Instead of the tenth word of this sentence being "used," however, it should be "consumed," which is the accepted term for use, plus waste.

Irrigation is one of the oldest forms of the use of water by Man, dating back thousands of years. Copies, engraved on stone, of the

Mr. Herschel. rules established in Roman times for dividing irrigation water among the owners of certain lands, have been dug up, and show that the division was by designated hours' run, of certain watercourses. With this method, there were crude devices for halving, or otherwise roughly dividing streams of water.

In the 16th century, in Italy, the first attempts were made to allow only a fixed quantity of water to flow on a certain piece of land, whether or not the level of the water in the main or branch ditch varied materially. This was done with the so-called modules; and now at length we are on the brink of alloting, by measure, the water consumed on the premises of the land-owner or farmer; without which, as will presently appear, there can be no proper and economical use of the water applied to the land.

This results from certain attributes of human nature, unchangeable through the centuries past and to come. No man will work industriously to attain a maximum result from the application to the land of a minimum of water, unless he pays for such use according to the quantity consumed.

Again: No man will take pains even to shut off the flow in his irrigation ditch when he is not using it, if it costs him no more to let it run. More than this: He will enjoy letting it run to waste through his land, as long as he has the right thus to let it run.

From studies made by the writer, on the basis of experiments in the arid lands of the United States, he has become convinced that greater crops per acre could be raised in this country, if only half as much water per acre were used in irrigation.

The full meaning of this result of irrigation experiments in the United States is not at once apparent. If 500 cu. ft. per sec. be devoted to irrigation, and the water is sold or let as has been done hitherto, they will irrigate, let us say, 2 000 40-acre farms; but, in order to get the maximum crops per acre, they should be made to irrigate 4 000 40-acre farms.

Assume the cost of the "system," water-rights, dam, main ditch, main branches, etc., to be $2 400 000, then we shall get poor or mediocre crops on 80 000 acres, on which $30 per acre has to be paid as the price for water, instead of getting a maximum of crops per acre on 160 000 acres, at the same total cost for water-rights, dam, main ditch, etc., and with a tax of only $15 per acre. In one case the 40-acre farmer has paid $1 200 for water, and raises poor crops; while, in the other case, the 40-acre farmer pays only $600 for water, and raises the maximum yield per acre of which the land and crop raised are capable.

It will be seen that the importance of all this to the State and to the Nation can hardly be overestimated, especially when it is considered that while there is plenty of arid land, there will always be a limited supply of water to irrigate it.

Mr. Herschel.

Now, as human nature, or selfishness, is unchangeable, as far as observations have gone, there is only one way to produce this great and widely beneficial improvement in irrigation farming. Each farmer must pay for water according to the quantity used and wasted on his premises; with a limitation as to the maximum quantity which he may draw at any time, so that the ditches will not be overburdened by too many parties making an overdraft at the same time. To charge ten times the sum for overdraft which, otherwise, would have become due on account of lawful draft, has proved to be, in water-power administration, a sufficient deterrent to keep parties within their lawful quantities.

Passing on to practical matters: No system of watchmen, or ditch riders, or hydraulic engineers armed with the clumsy implements of their hydrometric profession, such as current meters, Pitot tubes, weirs, and the like, will be able to enforce obedience to local laws, such as have been described. All these work too slowly, and to carry out the allotted task in this way would cost absurd and impracticable sums. The only practical way is to apply to every 40-acre farm a recording meter, which then becomes both a meter and a day and night watchman for each farm.

Such meters have been in use to measure other water, these 20 years or more, and need not now be invented, but they must not be expected in answer to the mistakenly conservative saying: "When we can get meters for $10 or $15 apiece, we will meter irrigation water."

In the first place, no mere meter will ever accomplish the desired end. It must be a recording meter, having watchmanlike qualities, which are fully as valuable in the considered position as is its meter work.

In the second place, why should the combined watchman and metering service be expected for any such sum as $10 or $15? It is palpably worth twentyfold or fortyfold these sums. The number of acres irrigated would be 160 000, instead of 80 000; the cost for water would be $15 per acre, instead of $30; a maximum of crops would be raised, instead of a mediocre crop; and the water would be used on the land, instead of being partly used, and partly wasted, and drowning out other lands by seepage.

Such results should not be expected for $10 or $15 per 40-acre farm; they would be cheap at $200 or $400, or still more, per 40-acre farm.

Mr. Follansbee.

Robert Follansbee, Assoc. M. Am. Soc. C. E. (by letter).—The writer wishes to emphasize the idea brought out by Mr. Stevens, that, unless more refined methods are used, the work of measuring the flow in irrigation canals will give much less accurate results than measurements of rivers.

Mr. Follansbee.

In 1906 and 1907 the writer was in charge of the water resources investigations of the U. S. Geological Survey in Montana. There were about seventy-five gauging stations in the district, including those on a dozen irrigation ditches. Almost without exception, these latter stations were subject to such changing conditions of flow, due to the silting up of the channel, use of check-gates, sudden changes of flow due to operation of head-gates, etc., that it was not possible to utilize the ordinary methods for river stations. It was necessary to have measurements made at intervals ranging from 1 to 2 weeks during the operating season. On most of the canals the staff gauge was read at least once a day, and oftener when the head-gates were changed. Wherever possible, the head-gate tender read the gauge, and thus knew when the gates were changed. The daily discharge was computed from a series of rating curves, each applicable for a short time only.

Not only is it more difficult to secure accurate records of flow in irrigating canals, but the need for more accurate records is greater than in the case of rivers. In the latter, the object of the records is to forecast the future flow, and as this has a wide yearly variation, a high degree of accuracy would not enable the forecast to be made any more correctly. Thus, as pointed out by Mr. Stevens, river records answer the chief purpose for which they are intended, if they are within 10 per cent.

The chief use of canal records, however, is to show the quantity of water available for the different users, and, in connection with waste measurements, to show the actual quantity used in irrigating a given crop. As water is one of the most valuable of the natural resources in the arid and semi-arid sections, it is essential that the information for irrigation canals be more exact than that for rivers.

Vol. XXXVI. DECEMBER, 1910. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

BOND-FRICTION-RESISTANCE IN REINFORCED CONCRETE.

Discussion.*

By Messrs. Edward Godfrey, Joseph T. Maguire, A. N. Talbot, Hector Robins Burroughs, and William Fry Scott.

Mr. Godfrey.

Edward Godfrey, M. Am. Soc. C. E. (by letter).—Although this paper does not give specific conclusions for practical designing, it could be made a basis for such conclusions. As the writer is interested in reform in reinforced concrete construction, he would like to call attention to the fact that some of the author's conclusions, drawn from a critical study of tests, agree exactly with his own, which are based on a rational analysis of common practice, as set forth in his paper, "Some Mooted Questions in Reinforced Concrete Design."† As the writer is also interested in rational, that is, common-sense, analysis and correct logic, he would like to call attention to some errors, both original and borrowed, in Mr. Scott's paper.

In regard to the spacing of rods or bars, Mr. Scott quotes at length from Maurer and Turneaure,‡ and apparently with approval. It is surprising that he has not kept in closer touch with the literature on this subject. He refers later to the writer's paper in which the large error of this very quotation was expressly referred to, as well as the participation in the same by three other well-known authorities. The threefold error in this quotation has been pointed out by the writer.§ It is simply this: If shear and bond stress are equal, the width of a beam must be equal to the sum of the perimeters

---

* This discussion (of the paper by William Fry Scott, Assoc. M. Am. Soc. C. E., printed in *Proceedings* for October, 1910, and presented at the meeting of December 7th, 1910), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

† *Transactions*, Am. Soc. C. E., Vol. LXX, p. 54.

‡ "Principles of Reinforced Concrete Construction."

§ *Engineering News*, Nov. 11th, 1909.

Mr. Godfrey. of all horizontal reinforcing rods; for it is the width of the beam which measures the area in horizontal shear, and the sum of the perimeters of the rods which measures the area in bond stress. It is an error to state that if the clear space between rods be equal to that portion of their perimeters below a plane through their centers, shear and bond stress will be equal. This neglects the fact that the portion of the perimeter above the center of a rod is not equal to the diameter. This is the first error. It is also an error to say that the portion of the perimeter of a square rod with its sides vertical below a plane through the center, is equal to one and one-half diameters; it should be two diameters. This is the second error. Neither is the perimeter below the center of a square rod set diagonally one diameter; it should be two diameters. This is the third error.

The writer believes he is justified in going thus minutely into this matter, because it is an astounding fact that this and other errors, to some of which he has already called attention, work their way through the literature of the subject like "leaven that tends to leaven the whole lump." Writers should try to correct these invidious errors, rather than perpetuate them by approving references to them.

One important point made by Mr. Scott is his emphasis of the vital necessity of considering the relation of the width of a beam to the sum of the perimeters of the horizontal reinforcing rods.

He refers to the rule of the Special Committeee on Concrete and Reinforced Concrete for spacing rods, as being in conformity with the theory heretofore referred to, which he quotes at such length. He fails to point out that this Committee, in the same paragraph of its report, allows a clear spacing between two layers of bars of not less than ½ in. This nullifies completely any semblance of "conformity with this theory." Mr. Scott missed an opportunity to characterize as monstrous, as it truly is, this authorized method of designing beams by crowding steel without limit into the bottom of a beam, when he found that his study of tests proved so conclusively the need of a large preponderance of concrete over steel and a wide spacing of rods.

In a large beam recently illustrated in an engineering periodical, there are shown five 1-in. round rods, five 1⅛-in. rods, and five 1¼-in. rods. The beam is 16 in. wide. The perimeters of these rods sum up to more than three times the width of the beam. None of the rods is anchored, except with a hook.

Mr. Scott says:

"Hooks on the ends of rods do not produce any increase in the strength of the reinforcement. They even tend to cause failure to occur sooner than when they are omitted."

He also says, "the most important point is to guard against sharp bends in the rods." The writer has long held these facts to be of the utmost importance. He emphasized them in his paper, before referred

Mr. Godfrey.

to, and holds them up in his book,* as elementary but neglected principles of correct design. His conclusion is based largely on rational and common-sense analysis. He is not, as one of the critics of his paper intimated, in the least concerned in being "placed right," but he is deeply concerned in seeing that the Engineering Profession is placed right in this and other vital matters of design. He would like, therefore, to add emphasis and endorsement to what Mr. Scott has said on these points.

The author's conclusions regarding stirrups appear to be about as follows: (1) They are not of much use except to help out a narrow beam; and (2) In a beam with some rods bent up, they are rather a hindrance than a help. These conclusions bear in the same direction as those of the writer, but they favor the stirrups unduly, because the conclusions are based largely on stirrups as a means of taking shear as against concrete alone, rather than against some rational means of shear reinforcement; and this is explained by the almost total absence in published tests of beams rationally reinforced for shear, that is, by curved-up rods anchored over the supports.

Mr. Scott deduces some of his theories, as to the internal stresses in a beam and their effect on the steel and concrete, from a totally erroneous premise. He gives a number of diagrams showing the actual and the apparent elongation of the steel in a reinforced concrete beam. The so-called actual elongation is in reality that calculated from the loading of the beam, and some of the complex theories of beams, which, strangely enough, assume a plane section after deflection, which Mr. Scott denies. The apparent elongation which is the actual stretch of the concrete beside the rod, as measured by extensometers, Mr. Scott finds to be much less under small loads and much greater under large loads than the "actual elongation."

This supposed difference in stretch of the rod and the surrounding concrete is explained by a theory which would appear to make of the concrete a material resembling gelatine in its properties. It is difficult to understand how the concrete could possibly stretch less than the steel, for it is the envelope of concrete which gives the stress, and, consequently, the stretch, to the steel. The concrete beam is loaded and deflected, and the steel relieves the concrete of part of its tension. It is also hard to see how a material like concrete could, in any event, stand the distortion incident to such differential stretch at its surface and at the surface of the steel, which may be but an inch or so beneath the surface of the concrete.

Of course, there will be a difference in stretch when the steel begins to slip, but the calculated stretch in the steel, estimated from its calculated stress and based on the complex and unsubstantiated

---

* "Structural Engineering: Concrete."

Mr. Godfrey. formulas in common use, is a value quite incompetent to determine the point where the bond is broken.

Mr. Scott's formulas for finding the stress in the steel reinforcement do not take into account the tension in the concrete. Of course, a working formula for reinforced concrete beams must omit the assistance rendered by the tension in the concrete, but this does not annihilate that tension, and this is a potent argument against the validity of formulas which use such fine-grained theory and cast out vitally important considerations. A theory which finds the tension a plain concrete member would have to stand (either a beam, a chimney, or an arch), and then provides steel to take this tension, as advocated by the writer, is all that the case demands for practical designing.

Theories for the minute investigation of the internal working of a beam would have to include every factor, and the tensile strength of the concrete in a beam is a very large factor in the strength of a whole beam, though apt to be rendered *nil* by a single crack.

Neglect of the aid which the tensile strength of the concrete supplies in resisting transverse strains is a full explanation of the difference, which in some cases amounts to several hundred per cent., that Mr. Scott would find between the apparent elongation and the so-called actual (really calculated) elongation.

From his study Mr. Scott further concludes that the gripping power of the concrete increases as the distance of the load from the support decreases. This, too, is completely accounted for in the method of finding stress in the steel which he used. L. J. Johnson, M. Am. Soc. C. E., has described some tests,* and has given his conclusions therefrom. The loads were placed very near the supports, and the apparent gripping power of the concrete was very high. The writer† afterward pointed out that Professor Johnson's conclusions were wrong and misleading, because what he calculated as the high gripping power of the concrete could be fully explained by calculating the beam as plain concrete. On the basis of Professor Johnson's reasoning, that is. neglecting the tension in the concrete, the thinnest kind of wire could have been used, and an apparent grip of any desired amount could seemingly be found.

Suppose the ultimate resistance to bending, of a plain concrete beam, were just equal to the bending moment that causes slip in the steel of the same beam reinforced, when the load is in the center of the span. At the point where the concrete fails in tension the steel must take up all the tensile stress. Is it not clear, then, that if the steel is calculated to take all the tension, its apparent bond strength is in reality measured by the transverse strength of the plain concrete beam? As this latter is a constant the apparent bond strength is

---

* *Journal*, Assoc. of Eng. Societies, June, 1907.

† *Engineering News*, August 29th, 1907.

Mr. Godfrey.

exactly in the inverse ratio of the distance from the support to the loading point. Thus, if the steel rod slips when a certain load is central on the beam, it will of course slip when twice that load is placed in two portions at quarter points, because the bending moment on the concrete beam is just the same. This could be anticipated before tests are made. It is not in the least surprising.

It is just such errors as this, attributing to the steel reinforcement wonderful properties which, in fact, are contained in the concrete, which tend to place reinforced concrete engineering on a low level. Exploiters of patented systems, such as slab and beam reinforcement. claim properties which are contained in the concrete itself.

Mr. Scott finds that the tensile strength of the reinforcing steel shows up better when the load is near the middle of the span than when it is near the end. This follows from the same reasoning, for after the concrete is once cracked and the tension is all on the steel, the holding power will naturally be greater for the greater embedment, even though initial slip has taken place.

The author's conclusion as to the small, uncertain, and only occasional benefit derived from deformed bars agrees with what the writer has pointed out in his book on concrete. There is scarcely an occasion where deformed bars are of any real advantage. If the concrete is properly made and hardened, it will grip the steel with all the force necessary, assuming that the rods are not too large in section and that there is sufficient concrete surrounding the steel. These features are essential in any design.

The advantage apparent in test beams which set under water and which have deformed bar reinforcement, is explained by the fact that such concrete will not shrink and grip the steel. Of course, shoulders and deformities in rods will take some hold, but dependence on these, without grip, is precarious. Reinforced work which is to be under water should have the reinforcement riveted, or should have other end connections, entirely independent of grip.

The writer agrees with Mr. Scott as to the misleading character of tests on finished structures. He also believes that there is a large amount of work yet to be done. This work, however, which is sadly needed, is not so much the making of tests, as the correct interpretation of tests already made, and the breaking down of persistent and groundless errors in the way of false interpretations, false logic, and baseless deductions.

Mr. Maguire.

JOSEPH T. MAGUIRE,* ESQ. (by letter).—With reference to the first part of this paper, dealing with the slipping of rods, yield point of bond, and differences between "actual" and "apparent" elongations, it is an acknowledged fact, that "actual" elongation cannot possibly be

---

* Bureau of Yards and Docks, Navy Dept., Washington, D. C.

Mr. Maguire. calculated, unless the tension value of the concrete is definitely known, and even then the relative distribution of load between the concrete and steel would make it a difficult problem to solve. For this reason it would seem that the charts illustrated in Figs. 1 and 2 do not show the actual existing differences between the two elongations; consesequently, their intersections would not give the true point of yield of bond. No attention whatever seems to have been given to any tension value of the concrete. The analysis of tests for the purpose of proving that the bond capacity of beams varies with the variations of cot. α seems to the writer to be fallacious, for the same reason, namely, that no attention has been paid to the tension value of the concrete.

Take, for instance, the results on Beams Nos. 21 and 5 of the Talbot series of 1905. A calculation of the former beam shows that it developed a bond strength of 88 lb. per sq. in. The actual failure of the beam was by tension in the steel, therefore it is safe to assume that its actual bond capacity was in excess of 88 lb. per sq. in. This beam was loaded at the center, and cot. $\alpha = 8.4$.

Beam No. 5, loaded at the one-third points, with cot. $\alpha = 5.6$, failed by the tension in the steel, and developed a bond strength of 103 lb. per sq. in. This bond strength, of course, was confined to that portion of the rod with varying bending moment, that is, from the point of support to the point of application of the load. If, instead of assuming that the variation in the position of the load created a variation in the capacity of the bond strength, it is assumed that the vertical concrete plane immediately under the load has value in tension, it can be demonstrated, quite readily, that, with an assumed value of 90 lb. bond strength in the rod, there is approximately 100 lb. tension in the extreme fibers of the concrete plane. As the value of concrete in tension is known to be considerably in excess of this, one can readily see why the beam did not fail by diagonal tension, and why the apparent bond was so high. Of course, had incipient cracks developed in the concrete at this plane of tension, due to the elongation of the steel, thus destroying its tension value, this line of reasoning would be fallacious, but no evidence has been adduced to prove the presence of these cracks at the crucial points.

Bond is a function of the molecular construction of the beam, and the writer fails to see how a modification of extraneous conditions can possibly affect its capacity. The method of analysis suggested above will explain satisfactorily every one of the tests used as a basis for the creation of the diagrams with varying cot. α, without admitting for a moment that the variation in the application of the load varies the capacity for bond.

Take, for instance, Beam No. 20 of the Talbot series of 1905: This beam was loaded at the one-third points, and failed by diagonal tension. It has the same cot. as Beam No. 5, yet it developed only a bond of

Mr. Maguire.

93.4 lb. per sq. in., and failed by diagonal tension, whereas Beam No. 5 developed a bond strength of 103 lb., and then failed by tension in the steel. On the basis of the argument suggested by the author, these bond values should have been nearly equal, and no explanation is offered for the discrepancy. On the basis of the analysis presented herewith, the reason for the failure of this beam, with such a low bond strength, was the presence of an incipient crack, just at or near the point of loading, which destroyed the tension value of the concrete. This seems to be a much more logical explanation than that offered by the diagrams.

Beams Nos. 11, 13, 16, 17, etc., grouped in the original diagram, follow the same analysis as that suggested for Beam No. 5.

Beams Nos. 14, 15, and 18 failed by diagonal tension, and gave tension, on the outer face of the concrete plane, of about 280 lb. per sq. in., with an assumed bond capacity of 90 lb. per sq. in., which would account for their failure in diagonal tension.

With respect to the values of bond-friction-resistance, with variable ratio of summation of perimeters of rods to breadth of beam, the writer respectfully submits that no such table is capable of being created, unless the tension values of the concrete are known.

In the foregoing discussion where mention is made of tension in the concrete plane, and failure of the beam due to the same, at or near the point of loading, this is understood to be simply theoretical, as the beams may have failed by tension in the concrete to the left of the point of application of the load. The point intended to be made is simply this: When the increment of bond which the rods fail to compensate reaches a point beyond the value of the concrete in tension, the beam fails. This point may be anywhere on the beam, and will be determined by the position of the incipient cracks.

The writer submits the following calculations on beams of Professor Talbot's tests, showing bond, etc.:

Beam No. 21, 1905.—Loaded at center. Failed by tension in steel. Beam 8 in. wide, 10 in. deep to steel, and with neutral axis at 0.420 d from top of beam. Span = 12 ft. 0 in. Reinforcement, four $\frac{1}{2}$-in. rods. Center load = 9 500 lb. Bending moment, neglecting weight of beam, = 342 000 in-lb. Tension in steel, due to same, = about 51 000 lb. (approximate check on Professor Talbot's tests). Bond stress on rod = 88 lb. (still neglecting weight of beam), which checks Mr. Scott. This beam gave by tension in the steel, therefore it is safe to say that the bond was something in excess of 88 lb. per sq. in. Cot. $\alpha = 8.4$.

Beam No. 20, 1905.—Failed by diagonal tension. Same dimensions, reinforcement, and span as Beam No. 21. Loading at one-third points, 5 000 lb. at each point. Bending moment (without weight of beam) = 240 000 in-lb. Neutral axis, 0.445 d from top; $d = 8.52$ in. Tension

Mr. Maguire. in steel = 35 900 lb., which checks Professor Talbot, approximately. End bond, disregarding weight of beam, = 93.4 lb. per sq. in. This value may or may not be high for the bond, depending on whether or not tension cracks had been developed at the point of rupture of the beam by the elongation of the steel. Only a knowledge of everything that happened during the test could determine this. Cot. $\alpha = 5.6$.

Beam No. 5.—Failed by tension. Same dimensions. Load, 11 000 lb. at one-third points. Neutral axis, 450 d; $d = 8.5$ in. Moment (disregarding weight of beam) = 264 000 in-lb. Tension in steel = approximately 40 000 lb. per sq. in. Bond = 103 lb. per sq. in. over the one-third length of rods from point of support to point of loading.

Now, assuming that the bond was good for 90 lb. per sq. in., there is an unbalanced bond of 3 921 lb. This would give a tension on the outer fibers of the plane of the concrete (at the point where the bond changes from apparently 103 lb. to 0 lb.) of about 103 lb. per sq. in., which is away within safe limits, unless, as stated for Beam No. 20, incipient cracks had developed at this point, thus destroying the tension value of the concrete plane.

It will be noticed that Beams Nos. 5 and 20 were of the same dimensions, with absolutely the same reinforcement, and yet, Beam No. 20, with an applied load of 10 000 lb. at the one-third points, failed by diagonal tension (bond failure, really), whereas Beam No. 5 failed by tension with an applied load of 11 000 lb. at the one-third points. The bond in one case was 93.5 lb., in the other it was 103 lb., while the cot. α remained constant. This can be readily explained by the method of analysis presented herewith.

Beams Nos. 11, 13, 16, 17, 19, 23, and 26.—These are grouped with Beams Nos. 5 and 20, on Fig. 4, and are similar. All failed by tension; therefore they follow the general analysis indicated for Beam No. 5.

Beams Nos. 31 and 50.—These are in the same group, and were dissimilar only in the application of loads; they follow the same analysis.

Beam No. 30.—Same dimensions. Loaded at center, with 7 000 lb. Failed by tension in the steel. Bending moment = 252 000 in-lb. (without weight of beam). $d = 8.566$ in. Tension = approximately 37 500 lb. Bond = 65 lb. per sq. in. Of course, the real value was in excess of this, as the beam failed by tension in the steel.

Beam No. 14.—Load, 15 000 lb. at points 7½ ft. apart. Bending moment = 7 500 × 27 = 202 000 in-lb.; $d = 7.99$ in. Bond = 150 lb. per sq. in. Tension in concrete, allowing bond of 90 lb. per sq. in., = 282 lb. on the outer fiber. This beam failed by diagonal tension, due, in all likelihood, to failure of the tension plane referred to in the previous discussion.

Beams Nos. 15 and 18.—These gave results similar to those of Beam No. 14, though slightly higher.

Mr. Talbot.

A. N. Talbot, M. Am. Soc. C. E. (by letter).—In reading this paper, there is a feeling of disappointment in finding that it is based on such fallacious reasoning. The main thesis of the paper—the so-called new laws—has no logical connection with the data of the beam tests cited. The values given in the elaborate diagram, Plate CLXIX,* and in Fig. 13, are based on the calculated bond stress developed in a number of beam tests, but the author does not attempt to show that the bond stress was the cause of the failure, or even that it was connected with the failure, or influenced the loads carried by the beam. Naturally, for beams failing by tension in the reinforcing bars in the middle portion of the beam (as was the case with most of the beams referred to in Fig. 4), the loads carried will be greater as the load points approach the ends of the beam, and, therefore, the bond stress developed will be greater, but the author does not present any evidence that the bars slipped or that the condition of the bond stress with reference to a yield point of bond resistance affected in any way the load carried by the beam. Without such evidence the usual methods of analysis would be followed, and these indicate that the amount of bond developed in the beam tests cited have no more relation to the loads which the beam carried than does the percentage of reinforcement bear to the amount of compression strength which may be developed in a beam. As the whole structure of the argument is based on a fallacy, the further deductions are also without foundation, such as those on the influence of the angle, α, of the diagrams, and the relation of periphery of bars to width of beam.

Under the circumstances it does not seem necessary to discuss other parts of the paper further than to give examples of the many faulty statements presented. The lines given as "actual elongation" in Figs. 1 and 2 are said to have been "computed from the known value of the modulus of elasticity of the steel and from the value of the tension produced therein as calculated from the known forces acting on the specimen," but the elongation of the steel itself was not measured, and there is every reason to believe that this elongation, at least through the middle portion of the beam, does not differ greatly from the actual elongation of the concrete alongside of it, and, therefore, that the author's line is greatly in error. The statement on page 1246* (made without evidence to support it), that the first phenomena noted were a creeping of the rods, etc., is misleading, and the assertions made on page 1248* about the apparent slip being equal to the actual elongation of the rod, are absurd. Whatever relation there may be between bond resistance and normal pressure, the fanciful conception of a normal component to the bond stress given in Fig. 3 is not borne out by any tests which the writer has seen. The localized high elongations in steel at stresses well beyond the yield point have

---

* *Proceedings*, Am. Soc. C. E., October, 1910.

Mr. Talbot.

no bearing on the distribution of stresses in a beam, up to the yield point of the steel, either at the middle or outside the load points where bond stress is more highly developed. The greater bending moment developed with a single concentrated load than with distributed loads is not explained by the author's statements; it is easily explained on other grounds. The author avoids giving the value of the angle, α, which should be taken for a beam with a uniform load. It would also be interesting to know the author's basis for the statement that the yield point for bond resistance is three-eighths of the ultimate resistance regardless of the condition of the surface of the bar.

Any definite information throwing light on the action of reinforced concrete should be welcomed. Many matters are but imperfectly known. The action of the bond resistance between the steel and the concrete is a good subject for tests. The distance between bars and the thickness of concrete around the bars necessary to develop sufficient bond resistance under various conditions of loading and of bending up of bars, is an interesting topic for investigation and discussion. Under some conditions there is an intimate relation between the method of failure and the bond stresses, shearing stresses, and other stresses developed, and in such cases the conditions are very complex. It is hoped that fuller information on such matters will be obtained as time goes on. It is all the more unfortunate, then, that a paper should be presented having fallacies which invalidate the whole discussion. Fortunately, these are so patent that the careful reader should not be misled.

Mr. Burroughs.

Hector Robins Burroughs, Assoc. M. Am. Soc. C. E. (by letter).—This paper was read by the writer with special interest, inasmuch as he has been intending to present a paper of this character, which would throw some light on a subject which seems to be much in the dark, so far as he has learned from experience and association with men designing work of this class.

In reading the paper, the writer was impressed with the low values given, and on first thought it seemed that the bond-friction-resistance in a reinforced concrete beam is not consistent with the other allied elements of resistance. Under certain conditions and assumptions, this is believed to be true. Recently he had occasion to design several reinforced concrete slabs, which were supported on the tops of steel I-beam stringers in city highway bridges. After some study and discussion on the subject of bond stress, the writer adopted the formula:

$$v = \frac{V}{b' jd} \dots\dots\dots\dots\dots\dots\dots\dots (1)$$

for calculating the horizonal shear, from which the bond stress

$$\frac{V}{jd \Sigma O} \dots\dots\dots\dots\dots\dots\dots\dots (2)$$

in a beam, was derived, and assumed at 80 lb. per sq. in., as a maximum working value.

Mr. Burroughs.

In Formulas 1 and 2:

V = Total vertical shear at any section,
b' = Width of web of T-beam,
jd = Arm of resisting couple for any beam,
O = Perimeter of rod.

The specified maximum live load affecting the slab, was given as a 12-ton road roller. The stringers were generally 5 ft. from center to center, which was governed by the fact that it was likely that future trolley tracks would be required, and they were made of sufficient strength for that work.

In order to satisfy Formula 2 by the assumed allowable stress, it was found necessary to make the slabs considerably deeper and use more steel than the flexural stresses required. In other words, the percentage of steel depended on bond-friction-resistance, and was increased to 25 or 50% more than that required by flexure. It was possible to make the two required areas practically the same, by using smaller rods with closer spacing; but, as the rods were placed in the top and also in the bottom of the slab, the spacing was thought to be too close to permit of satisfactory tamping.

The writer understands that the author gives average values along the length of the bar. In a beam uniformly loaded, the bond-friction-resistance of the bar at the center, would be equal to the sum of the perimeters multiplied by one-half the length of the bar, multiplied by a value taken from Fig. 13. In Formula 2 the bond-friction-resistance depends on the shear or its function, bending increment, which is a parabola for a uniformly distributed load, and hence the movement of bond-friction-resistance increases accordingly toward the support. The author shows that the bond-friction-resistance increases as it approaches the support, and is therefore in direct relation to the stress. The values given in the paper being average values for the embedded length of the rod, it would seem that the actual values near the support were considerably greater than those given and are the values desired for computation when applying Formula 2.

The problem of computing bond-friction-resistance seems to be analogous to that of rivet spacing in a plate girder.

Comparing the results obtained by using allowable values from Fig. 13 multiplied by the embedded length of rod, multiplied by the sum of the perimeters, with the results obtained from Formula 2, will show from 25 to 50% greater resistance in favor of the results from the values in Fig. 13. This amounts to increasing the assumed maximum allowable value of 80 lb. per sq. in. The writer believes that the increment of resistance is the critical condition. If 80 lb. per sq. in. is a low value, what is a maximum allowable value?

It seems clear that incipient cracks are produced by increments of stress, and considering that the full strength of the beam is only partly realized, still its integrity is appreciably impaired, when these

Mr. Burroughs. cracks (which are likely to admit moisture and cause corrosion) appear.

The writer regrets that maximum allowable values, in addition to average values, were not obtained, in order that the generally accepted Formula 2 could be directly answered, by assigning safe values for bond-friction-resistance, where the shear is a maximum.

In continuous and simple beams the maximum shear is at the support. In continuous beams the bending moment is negative, and hence the bond-friction-resistance for tension is along the continuity rods, and is a maximum at the support. It may be seen that in short spans, where the bond-friction-resistance is the determining factor for steel percentage, the greatest amount of steel will obtain over the support, and the maximum positive bond-friction-resistance in the lower rods will be just beyond a point of contraflexure toward the center of the span, for a beam over two or more supports.

The author states that hooks at the ends of the rods did not increase the bond-friction-resistance. It seems clear that this might be expected, since bond-friction-resistance is measured by increments. The ultimate strength of a beam, after the bond had failed, would probably be increased by hooks and other similar anchors, the action changing from beam action to that of an arch.

Considering that deformed bars did not show an appreciable advantage over plain bars, the writer agrees with the author that they probably would with equal care in tamping. It may be that the so-called "chemical action," between concrete and the ordinary round rod is the cause of this anomaly and is not yet fully understood.

Mr. Scott. WILLIAM FRY SCOTT, ASSOC. M. AM. SOC. C. E.—The author of the paper will make a more extended reply when the discussions are all in. This note may be permitted to accompany the publication of the discussions in this number of *Proceedings* in order to avoid misapprehension. In one discussion it is stated that "it is * * * unfortunate that a paper should be presented having fallacies which invalidate the whole discussion." If by chance his finality had by a printer's mistake been made to read "it is fortunate that a paper should be presented having facts which invalidate the whole (previous) discussion," the author would have felt complimented. In the opinion of the author previous discussions of this subject have been based on vital misinterpretations of actual test results, and Professor Talbot, in saying that "the author does not present any evidence that the bars slipped" will eventually have to admit that he overlooked just such evidence in the paper. Such evidence is found in Professor Talbot's own report of tests; such evidence is demonstrated by a series of tests made by the author, and is corroborated by the experiments of Dr. Preuss of the Testing Materials Laboratory of the Technical College at Darmstadt, in a report received since this paper was prepared.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

EDWIN PELEG DAWLEY, M. Am. Soc. C. E.*

DIED OCTOBER 7TH, 1910.

Edwin Peleg Dawley, the son of Peleg and Lucinda W. Dawley, was born in Providence, R. I., on October 1st, 1853. He received his education in the public schools of Providence, and at Brown University, being a member of the Class of 1874. He began his professional career in the Engineering Department for Water and Sewer Construction of the City of Providence, where he served about 7 years.

In 1879 Mr. Dawley accepted the position of Engineer and Superintendent of the Interstate Telephone Company, having charge of the construction of its long-distance line between Boston and Providence. His work and ability brought him in contact with and claimed the attention of the officials of the New York, Providence, and Boston Railroad, who offered him a position in its Engineering Department. He was appointed Assistant to the Chief Engineer in 1882, and subsequently, on the death of the head of the department, was advanced to that office.

In his railroad experience Mr. Dawley showed marked engineering ability in the solution of the many problems involved in the extensive improvements and developments which were undertaken by the Railroad Company during the next decade, notably the improvements in the roadbed and the strengthening of bridges for the constantly increasing and heavier traffic, the abolition of grade crossings, the four-tracking from Pawtucket to Providence, etc., and the passenger and freight terminal facilities at Providence.

In 1892 the New York, Providence and Boston Railroad passed into the control of the New York, New Haven and Hartford Railroad Company, which company retained Mr. Dawley as Division Engineer. In 1903 he was made Assistant Chief Engineer, and in 1905 Engineer of Construction, with offices at Boston and Providence.

Perhaps the foremost of Mr. Dawley's engineering monuments was the design and construction of about a mile of double-track tunnel, and its approaches, through the East Side Hill, in Providence, which afforded direct connection of all the railroad company's electrified lines on the east side of Narragansett Bay, with the existing terminal improvements, and completed the last link in the chain of railroad terminal facilities in Providence, which had been in progress for nearly twenty years. A professional paper on this subject, "The East Side Tunnel and Its Approaches, Providence, R. I.,"* was presented by him to the Boston Society of Civil Engineers in the spring of 1909.

---

* Memoir prepared by George B. Francis, M. Am. Soc. C. E.

On April 1st, 1909, after 27 years of active service, he resigned his position with the railroad company, and opened an office as Consulting Engineer, in Providence, R. I., where, after a brief illness, he died on October 7th, 1910.

Although he had not been long in private practice, Mr. Dawley had been engaged on several important pieces of work. He was Consulting Engineer for the Commission appointed by the City of Pawtucket, R. I., to work out a plan for eliminating the grade crossings in Pawtucket, plans for which had been completed, but not acted on, at the time of his death.

He had also designed and nearly finished a storage reservoir dam in Smithfield, R. I., for the Woonasquatucket Reservoir Company.

Mr. Dawley was married three times: In 1880 to Mary H. Bliss, by whom he had two children; in 1888 to Florence N. French, by whom he had one child; and in 1906, to Mrs. Maud C. Freeman, who survives him, together with his two sons, Howard and Earl, and his daughter, Mrs. Lewis Ford.

Mr. Dawley was a man of genial disposition, high ideals, unwavering integrity, and exemplary character, who gave himself to his arduous professional duties with tireless energy and unflagging zeal.

He was a member of Harmony Lodge, A. F. and A. M., Calvary Commandery, Knights Templar, and the Scottish Rite.

Mr. Dawley was elected a Member of the American Society of Civil Engineers on April 1st, 1885. He was also a Member of the Boston Society of Civil Engineers.

STILLMAN WILLIAMS ROBINSON, M. Am. Soc. C. E.†

Died October 31st, 1910.

Stillman Williams Robinson was born on a farm near South Reading, Vt., on March 6th, 1838. His early life was that of a country boy, but he had such a love for mechanics that he served a four-year apprenticeship as a machinist. In this way he earned the money to defray the expenses of his early education and his preparation for college.

In 1860 he entered the University of Michigan, making the journey from his home principally on foot, and meeting his expenses by working as a machinist. In 1863 he was graduated from that university as a Civil Engineer, having supported himself, while in college, as an instrument-maker. He was particularly skillful in graduating thermometers, and this led to his first invention, made while in college, a machine for graduating such instruments.

---

* *Journal*, Assoc. of Eng. Societies, Vol. XLII, p. 293.

† Memoir prepared by the Secretary from material furnished by a Committee of the Faculty of Ohio State University.

After his graduation, Mr. Robinson entered the Government service as Assistant Engineer in the United States Lake Survey. He remained in this position until 1866, when he was appointed Instructor in Engineering at the University of Michigan. In 1870 he accepted the chair of Mechanical Engineering and Physics in the Illinois Industrial University (now the University of Illinois), where he established the first Department of Mechanical Engineering in the United States. In 1878 he became Dean of the College of Engineering. His versatility is illustrated by the fact that, while he was at the college, he designed and constructed the tower clock now furnishing time there.

In 1878 he was called to Ohio State University as Professor of Physics and Mechanical Engineering, and held this position until 1881, when the chair was divided and he became Professor of Mechanical Engineering. He held this position until 1895, when he resigned in order to devote his time to his extensive professional interests. In recognition of his distinguished services as a scientific inventor, investigator and writer, the Ohio State University, in 1896, conferred on him the degree of Doctor of Science, and, in 1899, elected him Emeritus Professor of Mechanical Engineering.

Professor Robinson possessed great originality and inventive genius, having secured about forty patents, many of which were fundamental and of great value. His inventions were the results of study, based on scientific research and mathematical investigation, and were designs rather than accidental discoveries. He was also the author of books and papers, and these are marked by originality and thorough research. In 1892, a paper entitled "Red Rock Cantilever Bridge,"* written by Samuel M. Rowe, Stillman W. Robinson, and Henry H. Quimby, Members, Am. Soc. C. E., was awarded the Thomas Fitch Rowland Prize. On the discovery of the Ohio gas fields, the problem of measuring the volume of flow, having been referred to Professor Robinson, was solved by him by his brilliant application of the Pitot tube, which resulted in the methods now generally used.

He had always a great interest in education, and, in 1890, organized an association of teachers of mechanical engineering, from which, in 1893, was evolved the present Society for the Promotion of Engineering Education. His retirement did not affect his interest in and love for the University. At various times he made valuable donations to the equipment of the Department of Mechanical Engineering, and finally established on a permanent foundation the Robinson Fellowship in Engineering.

Professor Robinson was an indefatigable worker, there being no limit to his enthusiasm and ambition in his profession. He was modest and retiring, never claiming credit for himself, though most generous in according it to his associates. He had a deeply sympathetic and very kindly nature, and was inflexible in his devotion to duty and his principles of integrity and honor. The work and success of those around him, both colleagues and students, interested him greatly, and he imparted to them his own enthusiasm, encouraging, stimulating, and rewarding them. His memory and influence will long be felt in the lives of those who follow after him, and who have taken up his work where he left it.

---

* *Transactions*, Am. Soc. C. E., Vol. XXV, p. 662.

On his death the following action was taken by the Faculty of the Ohio State University:

"Resolved: By the University Faculty that in the death of Professor Stillman W. Robinson the University loses one whose great and loyal service has left a deep impression on the history and development of this Institution, the Faculty an associate whose ability and scholarship has earned him a national reputation, and a friend whose personal influence has helped those around him in their work and professional advancement.

"That we extend our deep sympathy to his widow and family in their bereavement and sorrow.

"Resolved: That these resolutions be spread upon the minutes and a copy sent to the family.

"N. W. Low,
"Edward Orton, Jr.,
"Wm. T. Maguire,
"Committee."

Professor Robinson was elected a Member of the American Society of Civil Engineers on January 2d, 1884.

NORMAN ALFRED TAYLOR, Assoc. M. Am. Soc. C. E.*

Died August 29th, 1910.

Norman Alfred Taylor was born at Troy, N. Y., on January 12th, 1880. He received his early education at St. Paul's School, Troy, N. Y., and at the Troy Academy. At the Rensselaer Polytechnic Institute, from which he was graduated in 1902, Mr. Taylor was a prominent member of the Theta Xi Fraternity.

After he was graduated Mr. Taylor was connected with the firm of Snow and Barber of Boston, Mass., and assisted in the preparation of the plans and the installation of the sewage disposal system for the Village of Saratoga, N. Y. On the completion of this work he was appointed Assistant City Engineer of Troy, N. Y.

---

* Memoir prepared by John Flynn, Jr., M. Am. Soc. C. E.

For five years Mr. Taylor was connected with the Highway Department of the State of New York, having charge of the construction of an extensive system of roads in Eastern New York.

In the spring of 1910 he was engaged by the Standard Oil Company, in the capacity of Engineer, in the construction of bituminous highways, with headquarters at Baltimore, Md. While in that city he contracted typhoid fever, from which he died in Poughkeepsie, N. Y., on August 29th, 1910.

Although quiet and unassuming in his manner, Mr. Taylor was loved by all who knew him, for his personal qualities and for his ability as an Engineer. He had a rare capacity for detail, nothing in connection with his work being too unimportant to claim his careful personal attention.

Mr. Taylor married Miss Alice Reynolds of Troy, N. Y., who, with three children, Elizabeth, Catherine and Robert M. 2d, survives him. He is also survived by his father, Mr. Robert M. Taylor, and a sister, Miss Ruth Taylor, of Troy, N. Y.

Mr. Taylor was elected a Junior of the American Society of Civil Engineers on October 6th, 1903, and an Associate Member on December 5th, 1906. He was also a Member of the Society of Engineers of Eastern New York.

GEORGE HIGGINS MYERS, Jun. Am. Soc. C. E.*

Died October 10th, 1910.

George Higgins Myers was born at South Bend, Ind., on April 12th, 1883. He was graduated from the South Bend High School in 1901. In September, 1902, he entered Purdue University as a student in the Mechanical Engineering Department, but was compelled to give up his college course in January, 1905, on account of failing health.

From April to June, 1905, he served as Field Draftsman on the relocation survey of the Gila Valley, Globe and Northern Railway, and from July to December, 1905, he was employed as Draftsman and Calculator for F. C. Kelsey, Civil Engineer, of Salt Lake City, Utah.

From January to May, 1906, Mr. Myers studied surveying and masonry construction under G. E. P. Smith, Assoc. M. Am. Soc. C. E., University of Arizona. . In July, 1906, he came East and entered the employ of the Ransome and Smith Company, of New York City, acting as Engineer and Foreman on the construction of the Ansonia, Conn., Brass Foundry, until December of the same year.

In March, 1907, he was appointed Designing Engineer of the

---

* Memoir prepared by the Secretary from information supplied by C. H. Myers, M. D., and from material on file at the House of the Society.

Trussed Steel Concrete Company, which position he held until July, when he became Concrete Engineer and Superintendent for H. G. Christman and Company, Contractors, of South Bend, Ind.

In May, 1908, Mr. Myers returned to the West, serving as Denver Agent for the Trussed Steel Concrete Company until October. During this time he designed the roof and floors of the Cheesman Memorial.

In October, 1908, he entered the employ of Charles G. Sheely, Bridge Contractor, of Denver, Colo., as Assistant Engineer in charge of reinforced concrete and structural steel work. He remained with Mr. Sheely until 1910, when he took up his residence in Tucson, Ariz., where, on October 10th, he died from the effects of a pulmonary hemorrhage.

Mr. Myers was especially interested in concrete construction, and was a young man of great promise in his chosen profession.

Mr. Myers was elected a Junior of the American Society of Civil Engineers on June 1st, 1909.

AMERICAN SOCIETY
OF
CIVIL ENGINEERS

INSTITUTED NOVEMBER 5, 1852.

CONSTITUTION AND LIST OF MEMBERS

FEBRUARY 10TH, 1910.

HOUSE OF THE SOCIETY, 220 WEST FIFTY-SEVENTH STREET,
NEW YORK.

CONTENTS

PAGE

CALENDAR 4

CONSTITUTION 5

GENERAL INFORMATION 17

GEOGRAPHICAL DISTRICTS INTO WHICH THE TERRITORY OCCUPIED BY THE MEMBERSHIP IS DIVIDED (WITH MAP) 20

MEDALS AND PRIZES; RULES GOVERNING THE AWARD OF 22

AWARDS OF THE NORMAN MEDAL, THE THOMAS FITCH ROWLAND PRIZE, AND THE COLLINGWOOD PRIZE 24

ANNUAL CONVENTIONS; LOCATION AND DATE OF 28

LIST OF MEMBERS

- PAST-PRESIDENTS 30
- OFFICERS FOR 1910 31
- STANDING COMMITTEES 32
- SPECIAL COMMITTEES 32
- CLASSIFIED LIST:
  - HONORARY MEMBERS 33
  - CORRESPONDING MEMBERS 33
  - MEMBERS 34
  - ASSOCIATE MEMBERS 153
  - ASSOCIATES 237
  - JUNIORS 245
  - FELLOWS 274
  - SUMMARY 275
- GEOGRAPHICAL LIST 276
- SUBSCRIBERS TO THE BUILDING FUND (1881 TO 1886) 319
- PAST AND PRESENT OFFICERS 320
- DECEASED MEMBERS 327
- ALPHABETICAL LIST 349

HOUSE OF THE SOCIETY,

220 West 57th Street.

Cable Address:
"Ceas, New York."

Telephone:
5913 Columbus.

CALENDAR.

1910-11.

DATES OF MEETINGS IN BOLD-FACED TYPE.

FEBRUARY, 1910

S	M	T	W	T	F	S
		1	**2**	3	4	5
6	7	8	9	10	11	12
13	14	15	**16**	17	18	19
20	21	22	23	24	25	26
27	28					

MARCH

S	M	T	W	T	F	S
		1	**2**	3	4	5
6	7	8	9	10	11	12
13	14	15	**16**	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

APRIL

S	M	T	W	T	F	S
					1	2
3	4	5	**6**	7	8	9
10	11	12	13	14	15	16
17	18	19	**20**	21	22	23
24	25	26	27	28	29	30

MAY

S	M	T	W	T	F	S
1	2	3	**4**	5	6	7
8	9	10	11	12	13	14
15	16	17	**18**	19	20	21
22	23	24	25	26	27	28
29	30	31				

JUNE

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	**15**	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

JULY

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

AUGUST

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

SEPTEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	**7**	8	9	10
11	12	13	14	15	16	17
18	19	20	**21**	22	23	24
25	26	27	28	29	30	

OCTOBER

S	M	T	W	T	F	S
						1
2	3	4	**5**	6	7	8
9	10	11	12	13	14	15
16	17	18	**19**	20	21	22
23	24	25	26	27	28	29
30	31					

NOVEMBER

S	M	T	W	T	F	S
		1	**2**	3	4	5
6	7	8	9	10	11	12
13	14	15	**16**	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

DECEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	**7**	8	9	10
11	12	13	14	15	16	17
18	19	20	**21**	22	23	24
25	26	27	28	29	30	31

JANUARY, 1911

S	M	T	W	T	F	S
1	2	3	**4**	5	6	7
8	9	10	11	12	13	14
15	16	17	**18**	**19**	20	21
22	23	24	25	26	27	28
29	30	31				

NOTE. Regular meetings are called to order at 8.30 P. M.

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day and Christmas Day.

At the time of going to press the date of the Annual Convention had not been fixed.

CONSTITUTION

Adopted March 4th, 1891.*

ARTICLE I.—Name, Location and Object.

1.—The name of this Association shall be the American Society of Civil Engineers.

2.—The offices of the Society shall be located in the City of New York.

3.—Its objects shall be the advancement of engineering knowledge and practice and the maintenance of a high professional standard among its members.

4.—Among the means to be employed for this purpose shall be: meetings for the presentation and discussion of appropriate papers and for social and professional intercourse; the publication of such papers and discussions as may be deemed expedient; the maintenance of a library, the collection of maps, drawings and models, and the establishment of facilities for their use.

ARTICLE II.—Membership.

1.—The Corporate Members of this Society shall be designated as Members and Associate Members. There may also be connected with the Society, Honorary Members, Associates, Juniors and Fellows who shall be entitled to all the privileges of the Society, except the right to vote and to hold office therein; provided that Honorary Members elected from the Corporate Members of the Society shall retain their right to vote and to hold office.

2.—A Member shall be a Civil, Military, Naval, Mining, Mechanical, Electrical, or other professional Engineer, an Architect or a Marine Architect. He shall be at the time of admission to membership not less than thirty years of age, and shall have been in the active practice of his profession for ten years; he shall have had responsible charge of work for at least five years, and shall be qualified to design as well as to direct engineering works. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice. The performance of the duties of a Professor of Engineering in a technical school of a high grade shall be taken as an equivalent to an equal number of years of actual practice.

3.—An Associate Member shall be a professional Engineer or Architect not less than twenty-five years of age, who shall have been in the active practice of his profession for at least six years, and who shall have had responsible charge of work as principal or assistant for at least one year. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice.

---

* Amended October 3d, 1894; March 6th, 1895; October 6th, 1897; October 5th, 1898; October 3d, 1900; March 4th, 1903; October 7th, 1903, and October 7th, 1908.

4.—Any person having the necessary qualifications prescribed in this article to entitle him to admission to the grades of Member or Associate Member, shall be eligible for such membership, though he may not be practicing his profession at the time of making his application.

5.—An Associate shall be a person who, by scientific acquirements or practical experience, has attained a position in his special pursuit qualifying him to co-operate with engineers in the advancement of professional knowledge and practice, but who is not a professional engineer.

6.—A Junior shall not be less than eighteen years of age, and his connection with the Society shall cease when he becomes thirty-two years of age, unless he be previously transferred to another grade. He shall have had active practice in some branch of engineering for at least two years, or he shall have graduated from a school of engineering of recognized standing. Persons who are in the Junior class at the time of the adoption of this Constitution shall not have their status changed by the provisions of this section.

7.—Honorary Members shall be chosen only from persons of acknowledged eminence in some branch of engineering or the sciences related thereto. There shall not be more than twenty at any one time.

8.—Fellows shall be contributors to the permanent funds of the Society, though they may not be eligible for admission as Corporate Members.

ARTICLE III.—Admissions and Expulsions.

1.—Honorary Members shall be proposed by at least ten members, and shall be elected only by a unanimous vote of the Board of Direction. A Past-President, or a member of the Board of Direction proposed for Honorary Membership, shall not be required to vote either for or against his own admission.

A person elected an Honorary Member shall be promptly notified thereof by letter. The election shall be cancelled if an acceptance is not received within six months after the mailing of such notice.

All members other than Honorary Members shall be admitted to the Society only by vote of the Board of Direction, as hereinafter specified.

2.—An application for admission to the Society or for transfer from one grade to another shall embody a concise statement, with dates, of the candidate's professional training and experience; and shall be in a form and in such detail as may be prescribed by the Board of Direction. It shall be signed by the applicant, and shall contain a promise to conform to the requirements of membership, if elected. The applicant shall furnish the names of at least five Corporate Members to whom he is personally known. Each of these shall be requested by the Secretary to address a letter to the Board of Direction, on a form prescribed by said Board, stating the extent of the writer's personal knowledge of the applicant and of his professional work. If at least five of the Corporate Members named as references do not furnish the requisite endorsement, the Secretary shall call upon the applicant for additional names, and not until written communications shall have been received from at least five Corporate Members shall the application be considered by the Board.

Applications of engineers not resident in North America, and who may be so situated as not to be personally known to five Corporate Members, may be recommended for ballot by five members of the Board of Direction, after having secured evidence sufficient, in their opinion, to show that the applicant is worthy of admission.

3.—At stated periods, to be determined by the Board of Direction, there shall be issued to each member in any grade whose address is known, a list of all new applications received for admission or for transfer, which list shall be dated and shall contain a concise statement of the record of each applicant and the names of his references, with a request that members transmit to the Board any information in their possession which may affect the disposition of the applications. Not less than twenty days after the issue of such list, the Board of Direction shall consider these applications, together with any information in regard to the applicants that may have been received; may make further inquiries, if deemed expedient; shall classify the applicant with his consent, and on applications for admission shall vote thereon by ballot.

The Board shall have the power to elect persons to any grade, and to transfer persons from any grade to a higher grade of membership, and shall notify the membership of its action.

4.—The ballots shall be letter-ballots, in a form to be prescribed by the Board of Direction. They shall be mailed to each member of the Board of Direction, and shall state the date on which the ballot is to be canvassed, which shall be not less than twenty days after the issue of the ballot. At least twenty-five votes must be cast to constitute an election. Three or more negative votes shall exclude from election. In case of exclusion, no notice thereof shall be entered on the minutes, but the candidate shall be notified.

A rejected applicant may renew his application for membership or transfer at any time after the expiration of one year from the date of the ballot rejecting his previous application.

5.—All elected candidates shall be duly notified and shall subscribe to the Constitution and Rules of the Society. Forms for these purposes shall be prescribed by the Board of Direction. If these provisions are not complied with within six months from the notification of election, such election shall be considered void, unless for special reason the time shall be extended by the Board of Direction.

Membership of any person shall date from the day of his election.

6.—Upon the written request of ten or more Corporate Members, that for cause therein set forth a person belonging to the Society be expelled, the Board of Direction shall consider the matter, and if there appears to be sufficient reason, shall advise the accused of the charges against him. He may, if he so desires, present a written defence which shall be considered at a meeting of the Board of Direction, of which he shall receive due notice. Not less than two months after such meeting, the Board of Direction shall finally consider the case, and if resignation has not been tendered, or a defence made which is satisfactory to the Board, it shall then notify the person that he will be expelled in one month, unless he elects to appeal from this decision. Appeals will be submitted to the Corporate Members by letter-ballot in a form to be prescribed by the Board of Direction. The ballot shall be accompanied by a statement of the charges, and of the action of the Board thereon, with such information as it deems proper, and also the statement of the person making the appeal. The ballot shall be canvassed by the Board not less than twenty days after its issue. A majority of the ballots cast will be required to sustain the action of the Board. The Board will notify the person and the Corporate Members of the result of the ballot. In case no appeal be made, the Board of Direction will expel the person, and notify him and the Corporate Members of its action.

7.—A member of any grade in the Society may resign his membership by a written communication to the Secretary, who shall present the same to the Board of Direction; when, if all his dues have been paid, his resignation shall be accepted.

8.—All persons elected and duly qualified, whose address on the records of the Society is within fifty miles of the Post Office in the City of New York, shall be deemed Resident; and those whose address is beyond that limit shall be deemed Non-Resident.

The classification of each person for the fiscal year as Resident or Non-Resident, shall be determined by the Records of the Society as they may appear on January 1st of that year.

ARTICLE IV.—Dues.

1.—The entrance fees payable on admission to the Society shall be as follows: by Members, thirty dollars; Associate Members, twenty-five dollars; Associates, twenty dollars; Juniors, ten dollars.

2.—The annual dues payable by members, whether Resident or Non-Resident, shall be as follows: by Corporate Members, fifteen dollars; Associates, ten dollars; Juniors, ten dollars.

3.—In addition to the dues prescribed in the preceding section, each Resident Member shall pay annually as follows: Corporate Members, ten dollars; Associates. five dollars; Juniors, five dollars.

4.—A person transferred from any grade to a higher one shall pay the difference between the entrance fees of the two grades, and his annual dues shall be those of the higher grade.

5.—The annual contributions shall become due for the ensuing year on the first day of January, and shall be payable in advance. It shall be the duty of the Secretary to notify each member of the amount due for the ensuing year at the time of giving notice of the Annual Meeting.

6.—Persons elected after six months of any fiscal year shall have expired, shall pay only one-half of the amount of dues for that fiscal year.

7.—All future annual dues may be compounded by a single payment by a Corporate Member of $250; or by an Associate of $150. Should a compounding Associate be elected to Corporate Membership he shall pay the further sum of $100.

Provided, that all compounding Corporate Members or Associates who may be or hereafter become Resident, shall be and remain liable for the annual payment of the difference between the annual dues of Resident and Non-Resident Corporate Members, or Associates; but any Corporate Member may at any time compound for the future payment of all annual dues of every nature and kind by the payment of $75 in addition to the $250 hereinbefore named; and any Associate may at any time compound for the future payment of all annual dues as Associate by the payment of $40 in addition to the $150 hereinbefore named.

Provided, that any person desiring to compound for future dues shall have paid his entrance fee, all arrears of dues, and the annual dues for the current year, before the compounding sum may be available.

Persons compounding shall sign an agreement that they will be governed by the Constitution and Laws of the Society as they are now formed, or as they may be hereafter altered, amended or enlarged; and that in case of their ceasing to be connected with the Society from any cause whatever, the amount theretofore paid by them for compounding, and for entrance fees and annual dues, shall be the property of the Society.

All moneys thus paid in commutation of annual dues shall be invested as a permanent fund, only the interest thereupon being subject to appropriation for current expenses.

8.—Any person whose dues are more than three months in arrears shall be notified by the Secretary. Should his dues not be paid when they become six months in arrears, he shall lose the right to vote or to receive the publications of the Society. Should his dues become nine months in arrears, he shall again be notified in form prescribed by the Board of Direction, and if such dues become one year in arrears, he shall forfeit his connection with the Society. The Board of Direction, however, may, for cause deemed by it sufficient, extend the time for payment and for the application of these penalties.

9.—The Board of Direction may, for sufficient cause, temporarily excuse from payment of annual dues any member who from ill health, advanced age, or other good reason assigned, is unable to pay such dues; and the Board may remit the whole or part of dues in arrears, or accept in lieu thereof, desirable additions to the Library, or collections.

10.—Every person admitted to the Society shall be considered as belonging thereto and liable for the payment of all dues until he shall have resigned, been expelled, or have been relieved therefrom by the Board of Direction.

11.—Persons elected as Fellows shall become such upon the payment of Two Hundred and Fifty dollars into the permanent funds of the Society. They shall not be liable for other fees and dues.

12.—The status of any present subscribers shall not be changed by the provisions of this Constitution.

ARTICLE V.—Officers.

1.—The officers of the Society shall be a President, four Vice-Presidents, eighteen Directors, a Secretary, and a Treasurer, who, with the five latest living Past-Presidents, who continue to be members, shall constitute the Board of Direction in which the government of the Society shall be vested, and who shall be the Trustees as provided for by the laws under which the Society is organized. For the election of Honorary Members, all the Past-Presidents shall be members of the Board of Direction, except any Past-President who may be disqualified by mental or bodily infirmity, and the evidence of said disqualification shall be a written certificate from his attending physician, or some officer of the Society.

2.—The terms of office of the President, Secretary and Treasurer shall be one year; of the Vice-Presidents, two years; and of the Directors, three years. Provided, however, that at the first election after the adoption of this Constitution, four Vice-Presidents and eighteen Directors shall be elected, of whom two Vice-Presidents and six Directors shall be elected to serve for one year only, and six Directors for two years only; provided, also, that after the first election two Vice-Presidents and six Directors shall be elected each year.

The term of each officer shall begin at the close of the Annual Meeting at which such officer is elected, and shall continue for the period above named or until a successor is duly elected.

3.—A vacancy in the office of President shall be filled by the senior Vice-President.

A vacancy in the office of Vice-President shall be filled by the senior Director. Seniority between persons holding similar offices shall be determined by priority of election to the office, and when these dates are the same, by priority of admission to Corporate Membership; and when the latter dates are identical, the selection shall be made by lot. In case of the disability or neglect in the performance of his duty, of any officer of this Society, the Board of Direction shall have power to declare the office vacant. Vacancies in any office for the unexpired term shall be filled by the Board of Direction, except as provided above.

4.—The President shall be ineligible for re-election. The Vice-Presidents and Directors shall not be eligible for re-election to the same office until at least one full term shall have elapsed after the end of their respective terms.

5.—At least one Vice-President, the Secretary and the Treasurer, and six Directors shall be Resident Corporate Members during their term of office.

ARTICLE VI.—Management.

1.—The President shall have a general supervision of the affairs of the Society. He shall preside at meetings of the Society and of the Board of Direction at which he may be present, and shall be *ex-officio* member of all committees. He shall deliver an address at the Annual Convention.

The Vice-Presidents in order of seniority shall preside at meetings in the absence of the President, and discharge his duties in case of a vacancy in the office.

2.—The Board of Direction shall manage the affairs of the Society in conformity to the laws under which the Society is organized and the provisions of this Constitution. It shall direct the investment and care of the funds of the Society; make appropriations for specific purposes; act upon applications for membership as heretofore provided; take measures to advance the interests of the Society; appoint all its employees; and generally direct its business. The Board of Direction shall make an annual report at the Annual Meeting, transmitting the report of the Treasurer and of other officers, and of Committees.

3.—The Treasurer shall receive all moneys and deposit the same in the name of the Society. He shall invest all funds not needed for current disbursements, as shall be ordered by the Board of Direction. He shall pay all bills, when certified and audited, as provided by this Constitution and by rules to be prescribed by the Board of Direction. He shall make an annual report and such other reports as may be prescribed by the Board of Direction.

The Board of Direction shall secure a satisfactory surety for the faithful performance of his duties by the Treasurer, and shall renew the same during the month of January of each year.

4.—The Secretary shall be a Corporate Member of the Society. He shall be elected annually by the Board of Direction at the meeting to be held within twenty days after the Annual Meeting provided for in Section 7 of Article VI, or at an adjournment thereof, and shall hold the office for one year or until his successor is elected, provided that a majority of the whole Board of Direction shall be required to elect the Secretary; this vote to be given, if necessary, by letter.

He shall be, under the direction of the President and Board of Direction, the executive officer of the Society.

He will be expected to attend all meetings of the Society and of the Board of Direction; prepare the business therefor, and duly record the proceedings thereof.

He shall see that all moneys due the Society are carefully collected, and without loss transferred to the custody of the Treasurer.

He shall carefully scrutinize all expenditures, and use his best endeavor to secure economy in the administration of the Society.

He shall personally certify the accuracy of all bills or vouchers on which money is to be paid, and shall countersign the checks drawn by the Treasurer against the funds of the Society, when such drafts are known to him to be proper and duly authorized by the Finance Committee.

He shall have charge of the books of account of the Society, and shall furnish monthly to the Board of Direction a statement of receipts and expenses under their several headings, and also a statement of monthly balances. He shall present annually, to the Board of Direction, a balance sheet of his books, as of the 31st of December, and shall furnish, from time to time, such other statements as may be required of him.

He shall conduct the correspondence of the Society and keep full records of the same.

He shall have charge of the Society's house and its contents; shall supervise the work of all employees of the Society, and see that they diligently perform their respective duties.

He shall perform all other duties which may from time to time be assigned to him by the Board of Direction.

5.—The Board of Direction may also, if they deem it necessary, appoint an Assistant Secretary, who shall aid the Secretary and be under his immediate direction in all matters. His whole time shall be given to the Society.

6.—The Secretary and Treasurer shall be paid salaries to be determined by the Board of Direction; but such salaries shall not be reduced during the term of office, as provided in this Constitution. All other salaries shall be fixed, from time to time, by the Board of Direction.

7.—The Board of Direction shall meet within twenty days after the Annual Meeting, and shall then appoint from its members a Finance Committee of five, a Library Committee of five, and a Committee on Publications of five. At least three members of the Finance Committee, and two members of the other Committees, shall be resident within fifty miles of New York.

These Committees shall report to the Board of Direction, and perform their duties under its supervision.

8.—The Finance Committee shall have immediate supervision of the financial affairs of the Society; shall employ an expert accountant to audit the accounts monthly; shall approve all bills before payment, and shall make recommendations to the Board of Direction as to the investment of moneys, and as to other financial matters.

9.—The Library Committee shall have general supervision of the Library and the House of the Society and the property therein; shall make recommendations to the Board with reference thereto, and shall direct the expenditure for books and other articles of permanent value, of such sums as may be appropriated for these purposes.

10.—The Committee on Publications shall have general supervision of the publications of the Society, and of contracts and expenditures connected therewith.

11.—In the consideration of papers offered for presentation, those papers containing matter readily found elsewhere, those specially advocating personal interests, those carelessly prepared or controverting established facts, and those purely speculative or foreign to the purposes of the Society, shall be rejected. The Committee on Publications shall determine which papers shall be read in full, and which shall be printed after reading by title only. The Committee may return a paper to the writer for correction and emendation, and call to its aid one or more members of special experience relating to the subject treated, either to advise on the paper or to discuss it. Such papers as in the judgment of the Committee should appear in the *Transactions*, shall promptly, upon their acceptance, be printed and distributed to members of all grades; others shall, with the consent of the authors, be suitably indexed, and filed for reference, or the Committee may provide abstracts thereof, which, when approved by the authors, may be published instead of the original papers. Advance copies of papers and discussions may be sent out to the membership before final publication.

12.—Special committees to report upon engineering subjects shall be authorized, except as further provided in this paragraph, by a majority of the votes cast by the Society, and in the following manner: A proposition to appoint such a Committee shall be presented at a regular meeting of the Society, and if sustained, on a motion to refer the same to the Board of Direction, by an affirmative vote of not less than twenty-five Corporate Members, it shall be so referred.

The Board of Direction shall then consider the same and report its recommendations to the Society at the next general business meeting, together with a statement of the arguments for and against the appointment of such Committee.

If a motion for the issue of a letter-ballot thereon receive the affirmative vote of two-thirds of the Corporate Members present, the Board of Direction shall, within thirty days thereafter, issue the letter-ballot, accompanied by a statement of the arguments for and against the proposition.

A majority of a total vote of not less than one-third of the Corporate Membership of the Society shall be necessary for its adoption, whereupon the Committee so authorized shall be appointed by the Board of Direction.

Whenever, in the judgment of the Board of Direction, a special committee, appointed in the above prescribed manner, by reason of the long time required for its appointment, would be defeated in its object and be of no avail, then the Board of Direction shall be authorized to appoint forthwith a special committee to act in each case and report on each subject; the Board of Direction to report its action to the Society at its next regular meeting.

ARTICLE VII.—Nomination and Election of Officers.

1.—The Board of Direction shall, from time to time, divide the territory occupied by the membership into seven geographical districts, to be designated by numbers. District No. 1 shall be the territory within fifty miles of the Post Office in the City of New York. Each of the other six districts shall be, as nearly as practicable, contiguous territory; each shall contain, as nearly as practicable, an equal number of members, and they shall be designated as Districts Nos. 2, 3, 4, 5, 6 and 7. The Board shall announce such division to the Society on or before the first day of May in each year.

2.—At the Annual Meeting of each year, seven Corporate Members, not officers of the Society, one from each of the geographical districts, shall be appointed by the meeting to serve for two years; who, with the five living last Past-Presidents of the Society, shall be a committee to nominate officers for the Society.

The Board of Direction may prescribe the mode of procedure for appointing this Committee, and fill any vacancies occurring.

The Committee so appointed shall meet at the Annual Convention of the Society, and nominate candidates to fill the offices, named in Article V, so as to provide, with the officers holding over, a Vice-President and six Directors residing in District No. 1, and twelve Directors divided equally, with regard to number and residence, among the remaining districts, Nos. 2, 3, 4, 5, 6 and 7.

A list of nominees for the offices to be filled at the next Annual Election shall be presented by the Committee to the Board of Direction within ten days after the nominees have been selected.

3.—Directly after the first of October the aforesaid list of nominees shall be mailed to every Corporate Member whose address is known, provided that if any person shall be found by the Board of Direction to be ineligible for the office for which he is nominated, or should a nominee decline such nomination, his name shall not be sent out, but the Board shall substitute another name therefor. The Board shall also fill any vacancies that may occur in this list of nominees up to the time the ballots are sent out. Vacancies must be so filled as to preserve the geographical distribution of officers prescribed in Section 2 of this article.

4.—At any time before the first day of December, any ten or more Corporate Members may send to the Secretary additional nominations, signed by such members; but nominations so made must comply with Section 2 of this article, regarding the distribution of nominees among the several districts.

5.—At least thirty days before the Annual Meeting, there shall be mailed to every Corporate Member whose address is known a letter-ballot with envelopes for voting. This ballot shall include all the nominations made in accordance with this article. The names and residences of the nominees, their grades of membership, and, in the case of nominees for Directors, the number of the district in which they reside, shall be given. The names of the nominees for any one office shall be arranged alphabetically without distinguishing marks of any kind other than the designations named herein.

Voters may erase names from the printed ballot-list and may substitute the name or names of any other person or persons eligible for any office. But the number of names for each office on the ballot voted must not exceed the number to be elected at that time to such office, and the vote must be for the proper number of officers resident in each of the seven districts. Ballots not complying with these provisions shall be rejected.

Directions in accordance with these provisions shall be issued with the ballots.

6.—Ballots may be sent by mail to the Secretary, or may be presented to him at the Society House. They must be enclosed in two sealed envelopes, and the outer envelope shall be endorsed by the voter's signature.

The Secretary shall make from the signatures on the outer envelopes a list of the voters from whom ballots are received, which list shall be open to inspection by all Corporate Members. A voter may withdraw his ballot, and may substitute another, at any time before the polls close.

7.—The polls shall be closed at 12 o'clock noon on the first day of the Annual Meeting, and the ballots shall be canvassed publicly by tellers, who shall be appointed by the presiding officer.

The persons of each district who shall receive the highest number of votes for the office for which they are candidates shall be declared elected.

In case of a tie between two or more candidates for the same office, the Annual Meeting shall elect the officer from among the candidates so tied.

The presiding officer shall announce to the meeting the names of the officers elected, in accordance with this section.

ARTICLE VIII.—Meetings.

1.—A Convention of the Society for the reading and discussion of professional papers and for social intercourse shall be held annually at such time and place as the Society may determine.

2.—There shall be two general Business Meetings of the Society each year; the Annual Meeting, which shall be held at the offices of the Society on the third Wednesday in January, and at which the annual reports for the year ending December 31st previous shall be presented, and the ballot for officers canvassed; and a Business Meeting during the Annual Convention, which shall be held at a time and place to be determined by the Board of Direction.

At these meetings thirty Corporate Members shall constitute a quorum.

3.—Business Meetings shall be held monthly on the first Wednesday of each month, except during the months of July and August. At these meetings thirty Corporate Members shall constitute a quorum.

4.—In addition to the Annual Meeting and the Annual Convention meetings for the reading and discussion of papers shall be held as ordered by the Board of Direction.

5.—Special meetings may be called by the Board of Direction, and shall be so called on the request of thirty Corporate Members, which request shall state the purpose of such meeting. The call for such meetings shall be issued ten days in advance, and shall state the purpose thereof, and no other business shall be taken up at such meeting. At these meetings thirty Corporate Members shall constitute a quorum.

6.—The Society may adopt, from time to time, rules for the order of business at its meetings.

7.—Meetings of the Board of Direction shall be held at the time of the Annual Meeting and of the Annual Convention, at which meeting nine members shall constitute a quorum; and at such other times as the Board may determine, at which five members shall constitute a quorum.

ARTICLE IX.—Amendments.

1.—Proposed amendments to this Constitution must be reduced to writing and signed by not less than five Corporate Members, and be submitted and acted upon as follows:

2.—Amendments presented to the Secretary on or before the first Wednesday in November shall be sent by letter to the several Corporate Members of the Society at least twenty-five days previous to the Annual Meeting. Such amendments shall be in order for discussion at such Annual Meeting, and may be amended in any manner pertinent to the original amendments by a majority vote of the Annual Meeting, and if so amended shall be voted upon by letter-ballot in form as amended by the Annual Meeting; if not so amended, they shall be voted upon by letter-ballot as submitted. The vote to be counted at the first regular meeting in March.

3.—Amendments presented to the Secretary not less than sixty days previous to the date of the Annual Convention shall be sent by letter to the several Corporate Members of the Society at least twenty-five days previous to the Annual Convention. Said amendments shall be in order for discussion at the Business Meeting during such Annual Convention, and may be amended in any manner pertinent to the original amendments by a majority vote of the Business Meeting during the Annual Convention, and, if so amended, shall be voted upon by letter-ballot in form as amended by said Business Meeting; if not so amended, they shall be voted upon by letter-ballot as submitted. The vote to be counted at the first regular meeting in October.

4.—If, after discussion of a proposed amendment, at either of the general meetings of the Society, the meeting shall so decide by a majority vote, it may refer the amendment to a Committee for further consideration, which Committee shall report at the next general meeting, whereupon the amendment shall be voted upon as hereinbefore provided.

5.—An affirmative vote of two-thirds of all ballots cast shall be necessary to the adoption of any amendment.

Amendments so adopted shall take effect thirty days after their adoption, provided that the officers of the Society, at the time any amendment may be adopted, shall continue in office until the next Annual Election.

GENERAL INFORMATION

Meetings.—Regular meetings are held at the House of the Society, No. 220 West Fifty-seventh Street, New York, on the first and third Wednesdays of each month, at 8.30 p. m., except during the summer. The Annual Meeting is held on the third Wednesday in January. A Convention is held annually, at a time and place determined each year by the Society.

The House and Library of the Society are open from 9 a. m. to 10 p. m. every day, except Sundays, Fourth of July, Thanksgiving Day and Christmas Day.

Publications.—The Society issues two publications, *Proceedings* and *Transactions,* which are furnished without extra charge to members of every grade. Subscription to *Proceedings* per annum is, for the United States, Canada and Mexico, $8; for foreign countries, $8.75. Single copies are $1 each. A special subscription rate of $4.50 per annum has been fixed for the *Proceedings*, for the benefit of students in technical schools. The subscription to *Transactions* per annum is, for the United States, Canada, and Mexico, $12; for foreign countries, $13. Single volumes are $4 each. Discount to libraries, book dealers, etc., 25 per cent.

Ten numbers of *Proceedings* are issued during the year, the numbers appearing on the fourth Wednesday of each month except June and July. Each number contains minutes of meetings, announcements of matters of current interest, a classified list of current engineering articles, and a list of new books received in the Library. Papers to be subsequently presented, as well as discussions to which they give rise, are also published in *Proceedings*.

The papers with complete discussions are subsequently republished in the volumes of *Transactions*, which, beginning with March 31st, 1909, have been issued quarterly. Each volume contains from 500 to 600 pages, and is bound in paper covers; arrangements have also been made for furnishing these volumes bound in standard cloth (50 cents), or half morocco ($1), to members who desire to pay for them in that form.

Professional Papers.—Papers and discussions on subjects of engineering interest are invited by the Board of Direction from all persons, whether members of the Society or not, subject to proper editorial supervision. Under the Constitution, matter which may be readily found elsewhere, advocates personal interests, is carelessly prepared, controverts established facts, or is purely speculative or foreign to the purposes of the Society, must be excluded.

GENERAL INFORMATION

Under a recent decision of the Board of Direction, papers will be divided into two classes, those which are of such general interest and of such form as to be adapted for oral discussion, and those which by reason of their technical nature cannot readily be discussed orally. Papers which form the first of these classes will be set down for presentation to a meeting of the Society, and oral as well as written discussion is solicited. Those coming under the second class will be published in *Proceedings*, and will not be presented at any meeting, but written discussions will be asked for, which will be published subsequently with the paper in the Volumes of *Transactions*.

All papers, on their acceptance by the Committee on Publications, become the property of the Society.

ADDITIONS TO LIBRARY.—It is desirable that copies of books on engineering subjects, and of reports of municipal, railway, canal, water supply and all other public works, be added to the Library. Members of the Society, and all who feel an interest in the proper maintenance of a technical reference library, are asked to donate engineering books or reports.

ADMISSION TO MEMBERSHIP.—The requirements for each of the grades of membership may be found on pages 5 and 6.

For blank forms and other information, address the Secretary, at the Society House.

FEES AND DUES.	RESIDENT.				NON-RESIDENT.			
	Members.	Associate Members.	Associates.	Juniors.	Members.	Associate Members.	Associates.	Juniors.
Entrance Fee	$30.00	$25.00	$20.00	$10.00	$30.00	$25.00	$20.00	$10.00
Yearly Assessment	25.00	25.00	15.00	15.00	15.00	15.00	10.00	10.00
Total, payable upon Election	$55.00	$50.00	$35.00	$25.00	$45.00	$40.00	$30.00	$20.00

Fellowship fee, $250 in one payment for life.

Annual dues are payable in advance on the 1st day of January.

Members elected during the last half of the year pay only one-half of the amount of dues for that year.

COMPOUNDING DUES.—The annual dues of a Corporate Member may be compounded by a single payment of $250; of an Associate by a payment of $150. Should a compounding Associate be elected to Corporate Membership, an additional payment of $100 is necessary.

All compounding Corporate Members or Associates, who may be or hereafter become Resident, remain liable for the annual payment of the difference between the annual dues of Resident and Non-Resident Corporate Members or Associates; but any Corporate Member may at any time compound for the future payment of all annual dues of every nature and kind by the payment of $75 in addition to the $250 hereinbefore named; and any Associate may at any time compound for the future payment of all annual dues as Associate by the payment of $40 in addition to the $150 hereinbefore named.

Any person compounding his dues must have paid his entrance fee, all arrears of dues, and the annual dues for the current year, before the compounding sum can be accepted.

Persons compounding shall sign an agreement that they will be governed by the Constitution and Laws of the Society as they are now formed, or as they may be hereafter altered, amended or enlarged; and that in case of their ceasing to be connected with the Society from any cause whatever, the amount theretofore paid by them for compounding, and for entrance fees and annual dues, shall be the property of the Society.

CERTIFICATES OF MEMBERSHIP.—The prices, to cover cost of Certificates, are as follows:

Parchment	$2.25
Parchment Paper	1.25

Certificates are not issued to Juniors.

BADGE.—This is of gold and enameled (Blue for Corporate Members, and Maroon for Associates and Fellows), with the member's name and membership number engraved on the back, and is mounted either as an ordinary pin, a scarf pin, a watch charm, or a button. The price is $5. Badges can be secured only upon application to the Secretary. They are not issued to Juniors.

REMITTANCES.—All remittances should be made payable to the order of the American Society of Civil Engineers.

THE SEVEN GEOGRAPHICAL DISTRICTS INTO WHICH THE TERRITORY OCCUPIED BY THE MEMBERSHIP IS DIVIDED, UNDER ART. VII, SEC. I, OF THE CONSTITUTION

District No. 1.—The territory within 50 miles of the Post-Office in the City of New York.

District No. 2.—The States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut (except as included in District No. 1), and all countries in Europe and Africa.

District No. 3.—The States of New York and New Jersey (except as included in District No. 1), the States of Michigan, Wisconsin, and Minnesota, the Territory of Alaska, and the Dominion of Canada.

District No. 4.—The States of Pennsylvania, Delaware, and Maryland, and the District of Columbia.

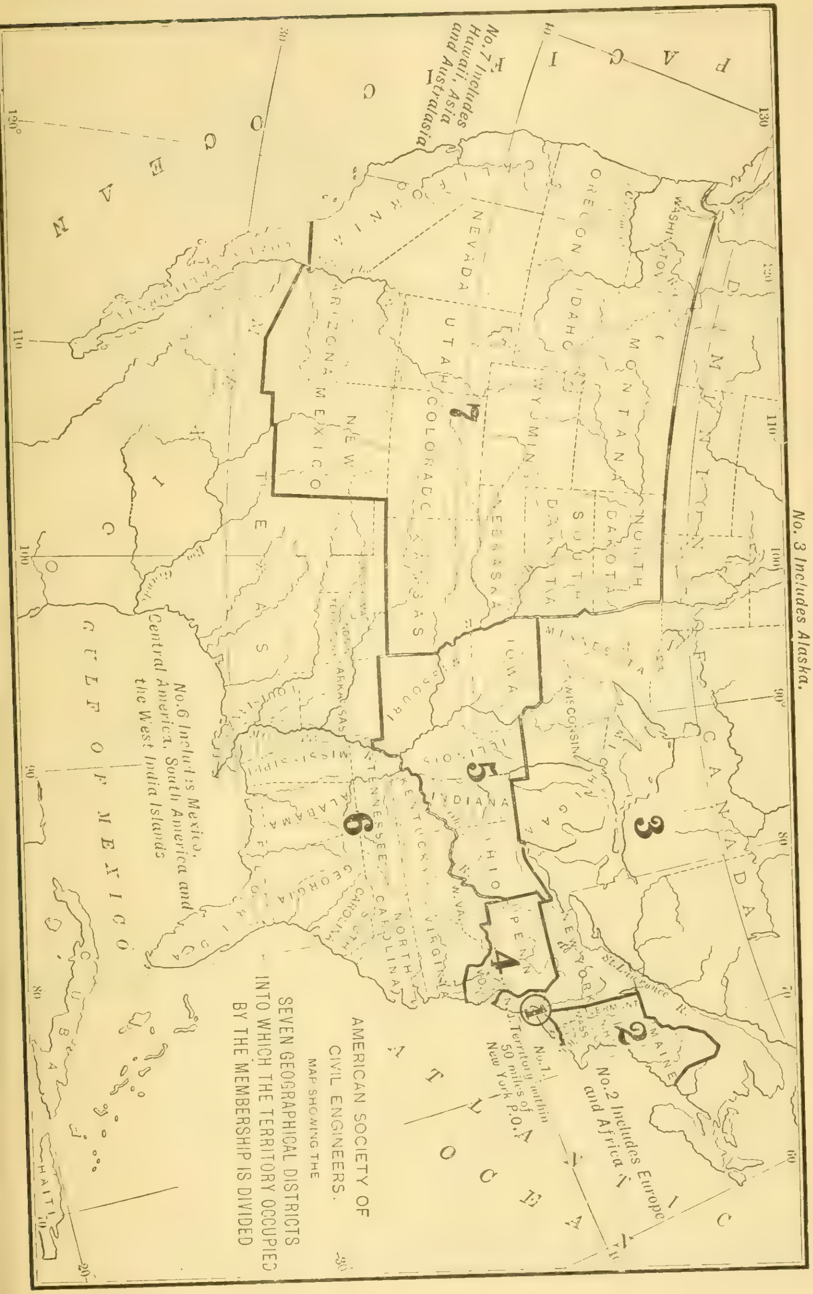
District No. 5.—The States of Ohio, Indiana, Illinois, Iowa, and Missouri.

District No. 6.—The States of Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas; the Republic of Mexico; the West India Islands; and all countries in Central America and South America.

District No. 7.—The States of North Dakota, South Dakota, Nebraska, Kansas, Montana, Wyoming, Colorado, Idaho, Utah, Washington, Oregon, California, and Nevada; the following Territories: New Mexico, Arizona, Hawaii; and all countries in Asia and Australasia.

These Districts are shown on the map on the next page.

GEOGRAPHICAL SUBDIVISIONS



AMERICAN SOCIETY OF CIVIL ENGINEERS.

MAP SHOWING THE

SEVEN GEOGRAPHICAL DISTRICTS INTO WHICH THE TERRITORY OCCUPIED BY THE MEMBERSHIP IS DIVIDED

No. 1. Territory within 50 miles of New York P.O.

No. 2 Includes Europe and Africa

No. 3 Includes Alaska.

No. 6 Includes Mexico, Central America, South America and the West India Islands

No. 7 Includes Hawaii, Asia and Australasia

RULES GOVERNING THE AWARD OF THE NORMAN MEDAL, THE THOMAS FITCH ROWLAND PRIZE, AND THE COLLINGWOOD PRIZE FOR JUNIORS

PRIZES.

There are at present three endowed prizes for papers published in the *Transactions* of the American Society of Civil Engineers. These prizes are awarded annually.

With the assent and the approval of the donors, by action of the Board of Direction, June 1st, 1897, the Society assumes the responsibility for the payment in perpetuity of the Norman Medal, Thomas Fitch Rowland Prize, and Collingwood Prize.

COMMITTEE ON PRIZES.

1. The Board of Direction shall appoint annually, not later than its regular meeting in June of each year, three Corporate Members of the Society, not members of the Board of Direction, who shall form a Committee to recommend the award of all prizes during the year.

2. The papers considered shall include all papers published in the *Transactions* during the year ending with the month of July.

3. The Committee on Prizes shall report its recommendation to the Board of Direction on or before December 31st, and the awards shall be made by the Board of Direction.

4. The announcement of the awards shall be made at the Annual Meeting.

5. The Secretary of the Society shall act as Secretary to the Committee on Prizes, but shall have no vote or voice in its deliberations.

CODE OF RULES.

The Norman Medal.—The Norman Medal was instituted and endowed in 1872 by the late George H. Norman, M. Am. Soc. C. E.

I. Competition for the Norman Medal of the American Society of Civil Engineers shall be restricted to members of the Society.

II. There shall be one gold medal awarded as hereinafter provided. The dies therefor shall be deposited with the Superintendent of the United States Mint at Philadelphia, in trust exclusively for the above purpose. Such medal shall be of a value of $60.

III. All original papers presented to the Society by members of any class, and published in the *Transactions* during the year for which the medal is awarded, shall be open to the award, provided that such papers shall not have been previously contributed in whole or in part to any other association, nor have appeared in print prior to their publication by the Society, nor have been published in the *Transactions* in any previous year.

IV. The medal shall be awarded to a paper which shall be judged worthy of special commendation for its merit as a contribution to engineering science.

The Thomas Fitch Rowland Prize.—The Thomas Fitch Rowland Prize was originally instituted by the Society at the Annual Meeting of 1882. It was endowed in 1884 by the late Thomas Fitch Rowland, Hon. M. Am. Soc. C. E. Its award is not restricted to members of the Society.

I. The prize shall consist of $60 in cash, with an engraved certificate signed by the President and Secretary of the Society.

II. In the award of this prize preference shall be given to papers describing in detail accomplished works of construction, their cost, and errors in design and execution.

The Collingwood Prize for Juniors.—The Collingwood Prize for Juniors was instituted and endowed in 1894 by Francis Collingwood, M. Am. Soc. C. E.

I. The competition for the prize shall be restricted to the Juniors of the Society.

II. The prize shall consist of $50 in cash, with an engraved certificate, signed by the President and the Secretary of the Society.

III. The prize shall be awarded to a paper describing an engineering work with which the writer has been directly connected, or it shall record investigations contributing to engineering knowledge, some essential part of which was made by the writer, and contain a rational digest of results. Any mathematical treatment must show immediate adaptability to professional practice. Accuracy of language and excellence of style will be factors in the award.

IV. These rules may be modified by the Board of Direction.

The awards of the Norman Medal, the Thomas Fitch Rowland Prize, and the Collingwood Prize for Juniors are indicated in the List of Members by the letters N., R., and C., respectively, prefixed to the name of each recipient.

AWARDS OF THE NORMAN MEDAL

1874. J. James R. Croes, for paper "Memoir of the Construction of a Masonry Dam." Vol. III,* p. 337.

1875. Theodore G. Ellis, for paper "Description and Results of Hydraulic Experiments with Large Apertures, at Holyoke, Mass., in 1874." Vol. V,* p. 19.

1877. William W. Maclay, for paper "Notes and Experiments on the Use and Testing of Portland Cement." Vol. VI,* p. 311.
Book Prize awarded to Julius H. Striedinger, for paper "On Igniting Blasts by Means of Electricity." Vol. VII,* p. 1.

1879. Edward P. North, for paper "The Construction and Maintenance of Roads." Vol. VIII,* p. 95.
Book Prize awarded to Max E. Schmidt, for paper "Notes on the South Pass Jetties." Vol. VIII,* p. 189.

1880. Theodore Cooper, for paper "The Use of Steel for Bridges." Vol. VIII,* p. 263.

1881. L. L. Buck, for paper "The Re-Enforcement of the Anchorage and Renewal of the Suspended Superstructure of the Niagara Railroad Suspension Bridge." Vol X,* p. 195.

1882. A. Fteley and F. P. Stearns, for paper "Description of Some Experiments on the Flow of Water Made During the Construction of Works for Conveying the Water of Sudbury River to Boston." Vol. XII,* p. 1.

1883. William P. Shinn, for papers "On the Increased Efficiency of Railways for the Transportation of Freight." Vol. XI,* p. 365; and "How can Railways be made more Efficient in the Transportation of Freight?" Vol. XII,* p. 189.

1884. James Christie, for paper "Experiments on the Strength of Wrought-Iron Struts." Vol. XIII,* p. 85.

1885. Eliot C. Clarke, for paper "Record of Tests of Cement Made for Boston Main Drainage Works." Vol. XIV,* p. 141.

1886. Edward Bates Dorsey, for paper "English and American Railroads Compared." Vol. XV,* p. 1.

1887. Desmond FitzGerald, for paper "Evaporation." Vol. XV,* p. 581.

1888. E. E. Russell Tratman, for paper "English Railroad Track." Vol. XVIII,* p. 217.

1889. Theodore Cooper, for paper "American Railroad Bridges." Vol. XXI,* p. 1.

1890. John R. Freeman, for paper "Experiments Relating to the Hydraulics of Fire Streams." Vol. XXI,* p. 303.

1891. John R. Freeman, for paper "The Nozzle as an Accurate Water Meter." Vol. XXIV,* p. 492.

1892. William Starling, for paper "Some Notes on the Holland Dikes." Vol. XXVI,* p. 559.

1893. Desmond FitzGerald, for paper "Rainfall, Flow of Streams, and Storage." Vol. XXVII,* p. 253.

1894. Alfred E. Hunt, for paper "A Proposed Method of Testing Structural Steel." Vol. XXX,* p. 181.

1895. William Ham. Hall, for paper "The Santa Ana Canal of the Bear Valley Irrigation Company." Vol. XXXIII,* p. 61.

1896. John E. Greiner, for paper "What is the Life of an Iron Railroad Bridge?" Vol. XXXIV,* p. 294.

1897. Julius Baier, for paper "Wind Pressures in the St. Louis Tornado, with Special Reference to the Necessity of Wind Bracing for High Buildings." Vol. XXXVII,* p. 221.

1898. B. F. Thomas, for paper "Movable Dams." Vol. XXXIX,* p. 431.

---

* *Transactions*, Am. Soc. C. E.

1899. E. Herbert Stone, for paper "The Determination of the Safe Working Stress for Railway Bridges of Wrought Iron and Steel." Vol. XLI,* p. 467.
1900. James A. Seddon, for paper "River Hydraulics." Vol. XLIII,* p. 179.
1902. Gardner S. Williams, Clarence W. Hubbell and George H. Fenkell, for paper "Experiments at Detroit, Mich., on the effect of Curvature upon the Flow of Water in Pipes." Vol. XLVII,* p. 1.
1904. Emile Low, for paper "The Breakwater at Buffalo, New York." Vol. LII,* p. 73.
1905. C. C. Schneider, for paper "The Structural Design of Buildings." Vol. LIV,* p. 371.
1906. John S. Sewell, for paper "The Economical Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures." Vol. LVI,* p. 252.
1907. Leonard M. Cox, for paper "The Naval Floating Dock—Its Advantages, Design and Construction." Vol. LVIII,* p. 97.
1908. C. C. Schneider, for paper "Movable Bridges." Vol. LX,* p. 258.
1909. J. A. L. Waddell, for paper "Nickel Steel for Bridges." Vol. LXIII,* p. 101.

---

* *Transactions*, Am. Soc. C. E.

MEDALS AND PRIZES

AWARDS OF THE THOMAS FITCH ROWLAND PRIZE[*]

1883. G. Lindenthal, for paper "Rebuilding the Monongahela Bridge, at Pittsburgh, Pa." Vol. XII,[†] p. 353.

1884. Hamilton Smith, Jr., for paper "Water Power with High Pressures and Wrought-Iron Water Pipe." Vol. XIII,[†] p. 15.

1885. A. M. Wellington, for paper "Experiments with New Apparatus on Journal Friction at Low Velocities." Vol. XIII,[†] p. 409.

1886. Charles C. Schneider, for paper "The Cantilever Bridge at Niagara Falls." Vol. XIV,[†] p. 499.

1887. William Metcalf, for paper "Steel: Its Properties; Its Use in Structures and in Heavy Guns." Vol. XVI,[†] p. 283.

1888. Clemens Herschel, for paper "The Venturi Water Meter: An Instrument Making Use of a New Method of Gauging Water; Applicable to the Cases of Very Large Tubes, and of a Small Value Only, of the Liquid to be Gauged." Vol. XVII,[†] p. 228.

1889. James D. Schuyler, for paper "The Construction of the Sweetwater Dam." Vol. XIX,[†] p. 201.

1890. O. Chanute, John F. Wallace and William H. Breithaupt, for paper "The Sibley Bridge." Vol. XXI,[†] p. 97.

1891. William H. Burr, for paper "The River Spans of the Cincinnati and Covington Elevated Railway, Transfer and Bridge Company." Vol. XXIII,[†] p. 47.

1892. Samuel M. Rowe, Stillman W. Robinson and Henry H. Quimby, for paper "Red Rock Cantilever Bridge." Vol. XXV,[†] p. 662.

1893. William Murray Black, for paper "The Improvement of Harbors on the South Atlantic Coast of the United States." Vol. XXIX,[†] p. 223.

1894. David L. Barnes, for paper "Distinctive Features and Advantages of American Locomotive Practice." Vol. XXIX,[†] p. 385.

1895. William R. Hill, for paper "The Water-Works of Syracuse, N. Y." Vol. XXXIV,[†] p. 23.

1896. H. St. L. Coppée, for paper "Bank Revetment on the Lower Mississippi." Vol. XXXV,[†] p. 141.

1897. Arthur L. Adams, for paper "The Astoria (Oregon) City Water-Works." Vol. XXXVI,[†] p. 1.

1898. Henry Goldmark, for paper "The Power Plant, Pipe Line and Dam of the Pioneer Electric Power Company at Ogden, Utah." Vol. XXXVIII,[†] p. 246.

1899. R. S. Buck, for paper "The Niagara Railway Arch." Vol. XL,[†] p. 125.

1900. Allen Hazen, for paper "The Albany Water Filtration Plant." Vol. XLIII,[†] p. 244.

1901. L. G. Montony, for paper "The Ninety-Sixth Street Power Station of the Metropolitan Street Railway Company, of New York City." Vol. XLIV,[†] p. 119.

1902. William W. Harts, for paper "Description of Coos Bay, Oregon, and the Improvement of Its Entrance by the Government." Vol. XLVI,[†] p. 482.

1903. George W. Fuller, for paper "The Filtration Works of the East Jersey Water Company, at Little Falls, New Jersey." Vol. L,[†] p. 394.

1904. George Cecil Kenyon, for paper "Dock Improvements at Liverpool." Vol. LII,[†] p. 36.

1905. Charles L. Harrison and Silas H. Woodard, for paper "Lake Cheesman Dam and Reservoir." Vol. LIII,[†] p. 89.

1906. George B. Francis and W. F. Dennis, for paper "The Scranton Tunnel of the Lackawanna and Wyoming Valley Railroad." Vol. LVI,[†] p. 219.

---

[*] This prize was known as the Rowland Prize from 1883 to 1896 and consisted of $50. Beginning with the award for 1897 it is to be known as the Thomas Fitch Rowland Prize and consists of $60, with an engraved certificate signed by the President and Secretary of the Society.

[†] *Transactions*, Am. Soc. C. E.

1907. James D. Schuyler, for paper "Recent Practice in Hydraulic-Fill Dam Construction." Vol. LVIII,† p. 196.
1908. Edward E. Wall, for paper "Water Purification at St. Louis, Mo." Vol. LX,† p. 170.
1909. William J. Wilgus, for paper "The Electrification of the Suburban Zone of the New York Central and Hudson River Railroad in the Vicinity of New York City." Vol. LXI,† p. 73.

AWARDS OF THE COLLINGWOOD PRIZE FOR JUNIORS

1895. Morton L. Byers, for paper "The Removal of the Channel Pier of the Cincinnati and Muskingum Valley Railway Bridge over the Scioto River." Vol. XXXI,† p. 361.
1896. Herbert Waldo York, for paper "The Twenty-Eighth Street Central Station of the United Electric Light and Power Company." Vol. XXXV,† p. 429.
1899. Julius Kahn, for paper "The Coal Hoists of the Calumet and Hecla Mining Company." Vol. XLI,† p. 269.
1900. Robert P. Woods, for paper "Street Grades and Cross-Sections in Asphalt and Cement." Vol. XLII,† p. 1.
1901. F. A. Kummer, for paper "A Proposed Method for the Preservation of Timber." Vol. XLV,† p. 181.
1903. Isaac Harby, for paper "The Footbridge for Building the Cables of the New East River Bridge." Vol. XLIX,† p. 165.
1904. Herbert J. Wild, for paper "The Substructure of Marsh River Bridge." Vol. LII,† p. 451.
1905. E. P. Goodrich, for paper "Lateral Earth Pressures and Related Phenomena." Vol. LIII,† p. 272.
1908. D. W. Krellwitz, for paper "Reinforced Concrete Towers." Vol. LX,† p. 160.
1909. H. L. Wiley, for paper "The Sinking of the Piers for the Grand Trunk Pacific Bridge at Fort William, Ontario, Canada." Vol. LXII,† p. 113.

---

† *Transactions*, Am. Soc. C. E.

LOCATION AND DATE
OF
ANNUAL CONVENTIONS

Number.	Location.	Date.	
First,	New York, N. Y.,	June,	1869
Second,	New York, N. Y.,	June,	1870
Third,	New York, N. Y.,	June.	1871
Fourth,	Chicago, Ill.,	June,	1872
Fifth,	Louisville, Ky.,	May,	1873
Sixth,	New York, N. Y.,	June,	1874
Seventh,	Pittsburg, Pa.,	June,	1875
Eighth,	Philadelphia, Pa.,	June,	1876
Ninth,	New Orleans, La.,	April,	1877
Tenth,	Boston, Mass.,	June,	1878
Eleventh,	Cleveland, Ohio.,	June,	1879
Twelfth,	St. Louis, Mo.,	May,	1880
Thirteenth,	Montreal, Que., Canada,	June,	1881
Fourteenth,	Washington, D. C.,	May,	1882
Fifteenth,	St. Paul and Minneapolis, Minn.,	June,	1883
Sixteenth,	Buffalo, N. Y.,	June,	1884
Seventeenth,	Deer Park, Md.,	June,	1885
Eighteenth,	Denver, Colo.,	July,	1886
Nineteenth,	Hotel Kaaterskill, N. Y.,	July,	1887
Twentieth,	Milwaukee, Wis.,	June,	1888
Twenty-first,	Seabright, N. J.,	June,	1889
Twenty-second,	Cresson, Pa.,	June,	1890
Twenty-third,	Lookout Mountain, Tenn.,	May,	1891
Twenty-fourth,	Old Point Comfort, Va.,	June,	1892
Twenty-fifth,	Chicago, Ill.,	July,	1893
Twenty-sixth,	Niagara Falls, N. Y.,	June,	1894
Twenty-seventh,	Hotel Pemberton, Hull, Mass.,	June,	1895
Twenty-eighth,	San Francisco, Cal.,	June,	1896
Twenty-ninth,	Quebec, Que., Canada,	June,	1897
Thirtieth,	Detroit, Mich.,	July,	1898
Thirty-first,	Cape May, N. J.,	June,	1899
Thirty-second,	London, England,	July,	1900
Thirty-third,	Niagara Falls, N. Y.,	June,	1901
Thirty-fourth,	Washington, D. C.,	May,	1902
Thirty-fifth,	Asheville, N. C.,	June,	1903
Thirty-sixth,	St. Louis, Mo.,	October,	1904
Thirty-seventh,	Cleveland, Ohio,	June,	1905
Thirty-eighth,	Frontenac, Thousand Islands, N. Y.,	June,	1906
Thirty-ninth,	City of Mexico, Mexico,	July,	1907
Fortieth,	Denver, Colo.,	June,	1908
Forty-first,	Bretton Woods, N. H.,	July,	1909

LIST OF MEMBERS

AUTHORIZED ABBREVIATIONS

HONORARY MEMBER	Hon. M. Am. Soc. C. E.
MEMBER	M. Am. Soc. C. E.
ASSOCIATE MEMBER	Assoc. M. Am. Soc. C. E.
ASSOCIATE	Assoc. Am. Soc. C. E.
JUNIOR	Jun. Am. Soc. C. E.
FELLOW	F. Am. Soc. C. E.

The Board of Direction requests the use of these abbreviations in all cases.

The awards of the Norman Medal, the Thomas Fitch Rowland Prize, and the Collingwood Prize for Juniors, are indicated in this list by the letters N., R., and C., respectively, prefixed to the name of each recipient.

It is particularly requested that every
change of address
be communicated immediately to:
The Secretary, American Society of Civil Engineers,
220 West Fifty-seventh Street,
New York, N. Y.

PAST-PRESIDENTS

James Laurie	Nov. 5, 1852, to Nov. 6, 1867.
James Pugh Kirkwood	Nov. 6, 1867, to Aug. 5, 1868.
William Jarvis McAlpine	Aug. 5, 1868, to Nov. 3, 1869.
Alfred Wingate Craven	Nov. 3, 1869, to Nov. 1, 1871.
Horatio Allen	Nov. 1, 1871, to Nov. 5, 1873.
Julius Walker Adams	Nov. 5, 1873, to Nov. 3, 1875.
George Sears Greene	Nov. 3, 1875, to Nov. 7, 1877.
Ellis Sylvester Chesbrough	Nov. 7, 1877, to Nov. 6, 1878.
William Milnor Roberts	Nov. 6, 1878, to Nov. 5, 1879.
Albert Fink	Nov. 5, 1879, to Nov. 3, 1880.
James Bicheno Francis	Nov. 3, 1880, to Jan. 18, 1882.
Ashbel Welch	Jan. 18, 1882, to Sept. 25, 1882.*
Charles Paine	Jan. 17, 1883, to Jan. 16, 1884.
DON JUAN WHITTEMORE	Jan. 16, 1884, to Jan. 21, 1885.
Frederic Graff	Jan. 21, 1885, to Jan. 20, 1886.
Henry Flad	Jan. 20, 1886, to Jan. 19, 1887.
William Ezra Worthen	Jan. 19, 1887, to Jan. 18, 1888.
THOMAS COLTRIN KEEFER	Jan. 18, 1888, to Jan. 16, 1889.
Max Joseph Becker	Jan. 16, 1889, to Jan. 15, 1890.
William Powell Shinn	Jan. 15, 1890, to Jan. 21, 1891.
OCTAVE CHANUTE	Jan. 21, 1891, to Jan. 20, 1892.
MENDES COHEN	Jan. 20, 1892, to Jan. 18, 1893.
William Metcalf	Jan. 18, 1893, to Jan. 17, 1894.
William Price Craighill	Jan. 17, 1894, to Jan. 16, 1895.
George Shattuck Morison	Jan. 16, 1895, to Jan. 15, 1896.
Thomas Curtis Clarke	Jan. 15, 1896, to Jan. 20, 1897.
BENJAMIN MORGAN HARROD	Jan. 20, 1897, to Jan. 19, 1898.
Alphonse Fteley	Jan. 19, 1898, to Jan. 18, 1899.
DESMOND FITZGERALD	Jan. 18, 1899, to Jan. 17, 1900.
JOHN FINDLEY WALLACE	Jan. 17, 1900, to Jan. 16, 1901.
John James Robertson Croes	Jan. 16, 1901, to Jan. 15, 1902.
ROBERT MOORE	Jan. 15, 1902, to Jan. 21, 1903.
ALFRED NOBLE	Jan. 21, 1903, to Jan. 20, 1904.
Charles Hermany	Jan. 20, 1904, to Jan. 18, 1905.
CHARLES CONRAD SCHNEIDER	Jan. 18, 1905, to Jan. 17, 1906.
FREDERIC PIKE STEARNS	Jan. 17, 1906, to Jan. 16, 1907.
GEORGE HENRY BENZENBERG	Jan. 16, 1907, to Jan. 15, 1908.
CHARLES MACDONALD	Jan. 15, 1908, to Jan. 20, 1909.
ONWARD BATES	Jan. 20, 1909, to Jan. 19, 1910.

In this list, the names of deceased Past-Presidents are printed in italics.

* Mr. Ashbel Welch died September 25, 1882, during his term of office as President.

OFFICERS, 1910

PRESIDENT

JOHN A. BENSEL

VICE-PRESIDENTS

Term expires January, 1911

GEORGE H. PEGRAM EMIL SWENSSON

Term expires January, 1912

JOHN T. FANNING HUNTER McDONALD

SECRETARY

CHARLES WARREN HUNT

TREASURER

JOSEPH M. KNAP

DIRECTORS

Term expires January, 1911

CHARLES L. HARRISON, GEORGE W. KITTREDGE, DEXTER BRACKETT, HORACE ANDREWS, GARDNER S. WILLIAMS, CHARLES S. CHURCHILL.

Term expires January, 1912

FRANCIS LEE STUART, SAMUEL C. THOMPSON, WILLIAM G. WILKINS, ARTHUR N. TALBOT, WILLIAM M. GARDNER, HORACE A. SUMNER.

Term expires January, 1913

WILLIAM E. BELKNAP, HORACE LOOMIS, GEORGE A. KIMBALL, PERCIVAL ROBERTS, Jr., CHARLES F. LOWETH, ARTHUR DeWINT FOOTE.

PAST-PRESIDENTS

(Members of the Board)

CHARLES C. SCHNEIDER, FREDERIC P. STEARNS, GEORGE H. BENZENBERG, CHARLES MACDONALD, ONWARD BATES.

ASSISTANT SECRETARY

THOMAS J. McMINN

Standing Committees of the Board of Direction

The President is *ex officio* a member of all committees

On Finance

GEORGE H. PEGRAM

CHARLES S. CHURCHILL
GEORGE A. KIMBALL
HORACE LOOMIS
WILLIAM G. WILKINS

On Publications

CHARLES L. HARRISON

HORACE ANDREWS
WILLIAM E. BELKNAP
FRANCIS LEE STUART
EMIL SWENSSON

On Library

GEORGE W. KITTREDGE

DEXTER BRACKETT
JOHN T. FANNING
HUNTER McDONALD
CHARLES WARREN HUNT

Special Committees

On Uniform Tests of Cement

GEORGE S. WEBSTER

RICHARD L. HUMPHREY
GEORGE F. SWAIN
ALFRED NOBLE
LOUIS C. SABIN
S. B. NEWBERRY
CLIFFORD RICHARDSON
W. B. W. HOWE
F. H. LEWIS

On Rail Sections

JOSEPH T. RICHARDS

C. W. BUCHHOLZ
E. C. CARTER
S. M. FELTON
ROBERT W. HUNT
JOHN D. ISAACS
RICHARD MONTFORT
H. G. PROUT
PERCIVAL ROBERTS, JR.
GEORGE E. THACKRAY
EDMUND K. TURNER

WILLIAM R. WEBSTER

On Concrete and Reinforced Concrete

C. C. SCHNEIDER

J. E. GREINER
W. K. HATT
OLAF HOFF
RICHARD L. HUMPHREY
ROBERT W. LESLEY
EMIL SWENSSON
A. N. TALBOT
J. R. WORCESTER

On Status of Metric System

STACY B. OPDYKE, JR.
D. A. MOLITOR

On Engineering Education

DESMOND FITZGERALD

BENJAMIN M. HARROD
ONWARD BATES
D. W. MEAD
CHARLES HANSEL

On Steel Columns and Struts

AUSTIN L. BOWMAN

ALFRED P. BOLLER
EMIL GERBER
CHARLES F. LOWETH
RALPH MODJESKI
FRANK C. OSBORN
GEORGE H. PEGRAM
LEWIS D. RIGHTS
GEORGE F. SWAIN
EMIL SWENSSON
JOSEPH R. WORCESTER

On Bituminous Materials for Road Construction

W. W. CROSBY
A. W. DEAN
H. K. BISHOP
A. H. BLANCHARD

CLASSIFIED LIST.

HONORARY MEMBERS.

[Hon. M. Am. Soc. C. E.]

		Date of Membership.	
Davidson, George. Prof. of Geography, Univ. of California, San Francisco, Cal		May	5, 1897
Fox, *Sir* Douglas. Cross Keys House, 56 Moorgate St., London, E. C., England	Cor. M. Hon. M.	June Mar.	7, 1871 5, 1901
Fritz, John. 155 Market St., Bethlehem, Pa	M. Hon. M.	July Sept.	5, 1893 5, 1899
Gray, George Edward. Cons. Engr.; U. S. Naval Hospital, Care, Dr. M. H. Simons, Mare Island, Cal	M. Hon. M.	July June	2, 1873 5, 1894
Mackenzie, Alexander. Retired Chf. of Engrs. and Maj.-Gen., U. S. A., The Birmingham, 2811 Adams Mill Rd., Washington, D. C	M. Hon. M.	Feb. May	2, 1887 12, 1905
Melville, George Wallace. Rear-Admiral, U. S. N. (*Retired*), 532 Walnut St. (Res., 620 N. 18th St.), Philadelphia, Pa		Dec.	20, 1899
Mills, Hiram Francis. Engr. of Proprietors of Locks and Canals on Merrimac River, Lowell, Mass		Nov.	30, 1909
White, *Sir* William Henry. 8 Victoria St., Westminster, London, S. W., England		Dec.	16, 1904

Honorary Members, 8.

CORRESPONDING MEMBERS.

Gleim, Charles Otto. Hon. Doctor of Eng.; Civ. and Cons. Engr., 184 Dorotheenstrasse, Hamburg, Germany	April	5, 1876
Pontzen, Ernest. 65 Rue de Monceau, Paris, France	Jan.	5, 1876

Corresponding Members, 2.

MEMBERS.

[M. Am. Soc. C. E.]

		Date of Membership.
Abbot, Frederic Vaughan. Col., Corps of Engrs., U. S. A., Office, Chf. of Engrs., Washington, D. C.		Dec. 3, 1884
Abbot, Frederick William. Pres., Abbot-Gamble Co.; Pres., Bryson-Gamble Co., 32 Broadway, New York City (Res., Dongan Hills, N. Y.)	Assoc. M. M.	Oct. 7, 1891 April 1, 1896
Abbott, Edward Lorenzo. 71 Broadway, New York City	Jun. Assoc. M.	Sept. 1, 1886 April 30, 1895 Mar. 6, 1906
Abbott, Elizur Tavarro. Gen. Mgr., Klamath Lake R. R. Co., Pokegama, Ore.		Oct. 7, 1908
Abbott, Fred Walter. 1328 Chestnut St., Philadelphia, Pa.		Sept. 7, 1904
Ackerman, John Walter. Cons. Municipal Engr. and Supt. of the Municipal Water-Works System, Auburn, N. Y.	Assoc. M. M.	Sept. 6, 1905 Jan. 7, 1908
Adam, Robert. 4a Calle Humboldt 35, City of Mexico, D. F., Mexico		May 2, 1900
R. Adams, Arthur Lincoln. Cons. Hydr. Engr., Balboa Bldg., San Francisco, Cal.		Oct. 2, 1895
Adams, Edwin Griggs, Jr. Tientsin, China	Assoc. M. M.	Jan. 1, 1896 Jan. 31, 1905
Adams, Frederick. S. Pearson & Son, 2a Puente de Alvarado 53, City of Mexico, D. F., Mexico		July 9, 1906
Adams, Henry Sewall. 108 Ames Bldg., Boston, Mass.		June 6, 1906
Aertsen, Guilliaem. Mgr., Latrobe Plant, Railway Steel-Spring Co., Latrobe, Pa.		Oct. 1, 1890
Affelder, Louis Jacob. Contr. Mgr., Am. Bridge Co. of N. Y., Frick Bldg., Pittsburg, Pa.	Jun. Assoc. M. M.	Feb. 4, 1896 June 5, 1901 June 5, 1906
Africa, James Murray. Cons. Engr.; City Engr., Huntingdon, Pa.		Sept. 2, 1896
Ahern, Jeremiah. Dixon, Cal.		May 4, 1904
Aiken, William Augustin. Vice-Pres., H. S. Spackman Eng. Co., 42 N. 16th St., Philadelphia, Pa.		Oct. 2, 1889
Aims, Walton Irving. 45 Broadway, New York City		May 4, 1904
Alber, Hermann. 218 West Sunset Boulevard, Hollywood, Cal.		Dec. 6, 1905

		Date of Membership.
Albertson, Charles. 529 Market St., Bangor, Pa.	Jun. Assoc. M. M.	Oct. 1, 1895 Mar. 1, 1899 Oct. 7, 1903
Alden, Charles Ames. Street Ry. Engr. of F. and S. Dept., Penn. Steel Co., Steelton, Pa.	Assoc. M. M.	May 4, 1898 Sept. 6, 1904
Alden, Herbert Clarendon. Asst. Engr., Bureau of Sewers, Jerome Ave. and Macombs Rd., Borough of Bronx, New York City	Assoc. M. M.	Mar. 1, 1893 Feb. 2, 1909
Alden, John Ferris. Cons. Engr., Rochester, N. Y.		July 6, 1887
Alderman, Charles Aldo. Chf. Engr., Buffalo & Lake Erie Traction Co., 535 Brisbane Bldg., Buffalo, N. Y.	Assoc. M. M.	April 6, 1898 April 2, 1902
Alderman, Clarence Edson. With Horton & Hemenway, Contrs. and Builders, Boston, Mass.	Assoc. M. M.	Sept. 6, 1905 Mar. 2, 1909
Aldrich, Truman Heminway. Room 1007, Brown Marx Bldg., Birmingham, Ala.		May 4, 1881
Alfred, Frank Hooker. Asst. to Pres., C., H. & D. Ry. Co., Carew Bldg., Cincinnati, Ohio		June 3, 1903
Alison, Thomas Henry. 149 Broadway, New York City		Oct. 7, 1908
Allan, Percy. Pres., Hunter Dist., Water Supply and Sewage Board; Dist. Engr., Newcastle, New South Wales, Australia	Assoc. M. M.	April 1, 1896 Oct. 1, 1902
Allard, Thomas Throp. Chf. Engr. with Champion & Pascual, Contrs. and Engrs., 101 Obispo St., Havana, Cuba		Mar. 2, 1909
Allen, Andrews. Contr. Engr., Wisconsin Bridge & Iron Co., 1127 Monadnock Bldg., Chicago, Ill.		Oct. 4, 1905
Allen, C. Frank. Prof. of R. R. Eng., Mass. Inst. Tech., Boston, Mass.		Feb. 6, 1878
Allen, Calvin Harlow. 1 West 72d St., New York City		Sept. 7, 1887
Allen, Charles Albert. Cons. Engr., Station A, Worcester, Mass.		June 4, 1879
Allen, Chauncey Loomis. Vice-Pres. and Gen. Mgr., Syracuse Rap. Trans. Ry. Co., Utica & Mohawk Val. Ry. Co., Oneida Ry. Co.; Pres., Syracuse & Suburban R. R. Co., Utica, N. Y.		Oct. 4, 1905
Allen, Henry Clayton. City Engr., City Hall, Syracuse, New York	Assoc. M. M.	July 1, 1891 Jan. 3, 1905
Allen, James Pierson. Asst. Engr., U. S. Engr. Office, 8 Ladson St., Charleston, S. C.	Jun. M.	Mar. 5, 1879 June 4, 1884
Allen, Kenneth. Engr., Met. Sewerage Comm. of New York, 17 Battery Pl., New York City		May 2, 1888
Allen, Walter Hinds. Civ. Engr., U. S. N., U. S. Naval Magazine, Hingham, Mass.	Jun. Assoc. M. M.	May 1, 1900 Nov. 4, 1903 Feb. 4, 1908

		Date of Membership.
Allen, William Andrew. Supt. of Constr., Am. Smelting & Refining Co., 165 Broadway, New York City	Assoc. M. M.	Feb. 6, 1901 Sept. 6, 1904
Allen, William Bullard. Mgr., Land Dept., Tennessee Coal, Iron & R. R. Co., 1314 Wancoma Ave., Birmingham, Ala.		Feb. 3, 1904
Allin, Thomas David. 203 Kendall Bldg., Pasadena, Cal.		Jan. 3, 1906
Almirall, Raymond Francis. Archt., 51 Chambers St., New York City		Oct. 5, 1904
Alvord, John Watson. Hydr. and San. Engr., 1212 Hartford Bldg., Chicago, Ill		Jan. 4, 1893
Ambler, John Nicholas. City Engr. and Supt. of Water-Works, Winston, N. C.		May 6, 1908
Ambursen, Nils Frederick. 176 Federal St., Boston, Mass.		Jan. 8, 1908
Amweg, Frederick James. Advisory Engr. & Mgr. of Bldg. Operations, 700 Marston Bldg., San Francisco, Cal.		Mar. 7, 1888
Andersen, Christian. Cons. Engr., P. O. Box 855, Spokane, Wash		Jan. 2, 1901
Anderson, George Gray. Cons. Engr., Room 18, Hughes Blk., Denver, Colo.		Feb. 7, 1906
Anderson, Joshua Thomas Noble. Springbank, Narbethong, Victoria, Australia		Nov. 7, 1906
Anderson, William Pope. Pres. and Chf. Engr., The Ferro Concrete Const. Co., Richmond and Harriet Sts., Cincinnati, Ohio		April 6, 1909
Andrews, Daniel Marshall. U. S. Asst. Engr., U. S. Engr. Office, Montgomery, Ala		Mar. 2, 1892
Andrews, David Herbert. Pres., The Boston Bridge Works, Inc., 38 Lake Ave., Newton Center, Mass		Sept. 2, 1885
Andrews, Hiram Bertrand. 166 Devonshire St., Boston, Mass.		Mar. 1, 1905
ANDREWS, HORACE. (*Director*). 125 Lancaster St., Albany, N. Y		April 6, 1887
Angier, Walter Eugene. 1750 Monadnock Bldg., Chicago, Ill.	Assoc. M. M.	Sept. 7, 1892 Sept. 3, 1902
Annan, Charles Le Roy. Office Engr., Dept. of Public Works, St. Paul, Minn		July 4, 1888
Anthony, Charles, Jr. Gen. Mgr., Bahia Blanca Water-Works Co., Casilla de Correo 149, Bahia Blanca, Argentine Republic		Mar. 5, 1902
Anthony, Charles Chapman. Asst. Signal Engr., P. R. R. Co., Broad St. Station, Philadelphia, Pa		Oct. 2, 1907
Appleton, Thomas. Supt. of Constr., U. S. Post Office, Alton, Ill		April 4, 1883
Arango, Ricardo Manuel. Envoy Extraordinary and Minister Plenipotentiary from the Republic of Panama to the Court of St. James, London, England	Assoc. M. M.	Sept. 2, 1896 Feb. 6, 1906

		Date of Membership.
Archbald, James. Cons. Engr., 424 Jefferson Ave., Scranton, Pa		May 15, 1872
Archer, William. Gen. Office, B. & O. S. W. R. R., Cincinnati, Ohio		Mar. 2, 1881
Archibald, Peter Suther. Cons. Engr., Moncton, N. B., Canada		Jan. 7, 1885
Arentz, Frederick Christian Holberg. Engr. and Contr., 627 Western Ave., Joliet, Ill	Assoc. M. M.	May 6, 1891 Oct. 3, 1900
Argollo, Miguel de Teive e. Pres., Bahia General Transportation Co., Caixa Postal 89, Bahia, Brazil		Oct. 2, 1895
Armstrong, Walter Root. Acting Supt., Mont. Div., Ore. Short Line R. R., Pocatello, Idaho		Oct. 4, 1905
Armstrong, William Coulson. Terminal Engr., C. & N. W. Ry. Co., 215 Jackson Boulevard, Room 804, Chicago, Ill.		June 1, 1909
Arnold, Bion Joseph. 181 La Salle St., Chicago, Ill		Mar. 1, 1905
Arnold, William Harry. Gen. Mgr., Bay State Dredging Co., Room 504, 185 Summer St., Boston, Mass		May 1, 1907
Arthur, Howard Elmer. Chf. Engr., Mosher Mfg. Co., Dallas, Tex.		Nov. 8, 1909
Artingstall, Samuel George. 117 South Hamilton Ave., Chicago, Ill		Oct. 6, 1886
Ash, Henry Clarke. Res. Engr., Minnesota & Ontario Power Co., International Falls, Minn		Oct. 3, 1906
Ashbaugh, Lewis Eugene. Hydr. Engr. with J. G. White & Co., 509 Alaska Commercial Bldg., San Francisco, Cal	Assoc. M. M.	Jan. 7, 1903 May 5, 1908
Ashbridge, Richard I Downing. East Downingtown, Pa	Assoc. M. M.	Sept. 3, 1902 April 30, 1907
Ashmead, Frank Milligan. Asst. to Prin. Asst. Engr., B. & A. V. Div., P. R. R., 428 Richmond Ave., Buffalo, N. Y.		July 6, 1887
Ashmead, Percy Herbert. Chf. Engr., Madeira-Mamoré Ry., Caixa 304, Manãos, Brazil		Mar. 6, 1907
Ashton, William. Chf. Engr., Ore. Short Line R. R., Salt Lake City, Utah		May 6, 1908
Aspinwall, Thomas. 3 Hamilton Pl., Boston, Mass		May 2, 1888
Asserson, Henry Raymond. 495 Sixth St., Brooklyn, N. Y.		Oct. 2, 1901
Atkinson, John Bond. Pres., St. Bernard Min. Co., Earlington, Ky		Sept. 5, 1877
Atterbury, William Wallace. Gen. Mgr., Penn. Lines East of Pittsburg and Erie, P. R. R., Broad St. Station, Philadelphia, Pa		Mar. 2, 1909
Atwater, Almon Byron. Asst. to Pres., Grand Trunk Western Ry., Detroit, Mich		May 5, 1886
Atwood, John Abiel. Chf. Engr., P. & L. E. R. R. Co., Pittsburg, Pa		Jan. 3, 1900
Auchincloss, William S. Atlantic Highlands, N. J		Feb. 17, 1869

		Date of Membership.
Auryansen, Frederick. Bridge Engr., Long Island R. R., 44 Union Hall St., Jamaica, N. Y....	Jun. Assoc. M. M.	Oct. 5, 1897 Dec. 3, 1902 April 6, 1909
Aus, Gunvald. Cons. Engr., 11 East 24th St., New York City..		April 3, 1895
Austin, William Eugene. Archt., 46 West 24th St., New York City		Dec. 7, 1904
Averill, Frank Lloyd. (Averill & Adams, Archts. & Engrs.), 719 Union Trust Bldg., Washington, D. C........	Assoc. M. M.	Jan. 6, 1897 May 6, 1903
Axtell, Decatur. Vice-Pres., C. & O. Ry. Co.; Chairman, Board of Directors, Tol. & Ohio Cent. Ry. Co., Richmond, Va........		Mar. 3, 1886
Aycrigg, William Anderson. Cons. Engr., 201 South 33d St., Omaha, Nebr........	Assoc. M. M.	May 4, 1892 May 4, 1898
Ayres, Clarence Morton. Chf. Engr., Central Iron & Coal Co., 614 Twenty-second Ave., Tuscaloosa, Ala........	Assoc. M. M.	Oct. 2, 1901 Oct. 31, 1905
Babb, Cyrus Cates. Dist. Engr., U. S. Geological Survey, Care, Maine State Water Storage Comm., Augusta, Me........	Jun. Assoc. M. M.	Feb. 2, 1892 Feb. 3, 1897 Mar. 1, 1904
Babcock, Henry Nash. U. S. Asst. Engr., Army Bldg., 39 Whitehall St., New York City........		Sept. 3, 1884
Bachert, Augustus Ellsworth. Gen. Supt., Rockhill Iron & Coal Co.; Chf. Engr., East Broad Top R. R. Co., Tyrone, Blair Co., Pa........		June 3, 1908
Bacon, George Morgan. 159 Pierpont Ave., Salt Lake City, Utah........	Assoc. M. M.	Dec. 3, 1902 Dec. 5, 1905
Bacon, James Hayward. Harbor Engr., Grand Trunk Pacific Ry. Co., Prince Rupert, B. C., Canada........		Jan. 3, 1900
Bacot, William Sinclair. 234 Genesee St., Utica, N. Y......		Oct. 1, 1890
Badenhausen, John Phillips. Contr. Engr. (Badenhausen & Hull, Inc.), 1530 Thirty-sixth Ave., Seattle, Wash....		Oct. 5, 1909
Bailey, William Melvin. Chf. Engr., Eastern Expanded Metal Co., Paddock Bldg., Boston (Res., 29 Auburn St., Malden), Mass........	Assoc. M. M.	Sept. 5, 1900 Mar. 3, 1908
Baily, Thomas Chalkley James, Jr. 531 Randolph St., N. W., Washington, D. C........		Oct. 4, 1905
Baird, Howard Carter. Prin. Asst. Engr., Boller & Hodge, 149 Broadway, New York City.....	Jun. Assoc. M. M.	June 6, 1893 Oct. 5, 1898 Feb. 2, 1904
Baird, Samuel Pond. Pres., Standard Brick Co., Charleston, W. Va........	Assoc. M. M.	Mar. 1, 1899 Sept. 4, 1906
Bakenhus, Reuben Edwin. Civ. Engr., U. S. N., U. S. Naval Station, Olongapo, Philippine Islands........		Oct. 2, 1907

		Date of Membership.
Baker, Charles Hinckley. Vice-Pres., Am. Cyanamid Co.; Vice-Pres., Muscle Shoals Hydro-Elec. Power Co., 100 Broadway, New York City		June 4, 1902
Baker, Holland Williams. U. S. Asst. Engr., 235 South Highland Ave., Pittsburg, Pa		May 7, 1890
Baker, Ira Osborn. Prof. of Civ. Eng., Univ. of Illinois, 702 West University Ave., Champaign, Ill		May 3, 1893
Baker, Shirley. Mgr., Excelsior Wooden Pipe Co., 916 Balboa Bldg., San Francisco, Cal	Jun. Assoc. M. M.	Sept. 11, 1900 June 3, 1903 June 2, 1908
Baker, William Edgar. 27 William St., New York City		June 1, 1898
Balch, William Hoyt. Ayudante Director, Direccion Genl. de Obras Publicas, Santo Domingo, Santo Domingo	Assoc. M. M.	April 1, 1903 Dec. 3, 1907
Baldwin, Archibald Stuart. Chf. Engr., I. C. R. R., Chicago, Ill		Dec. 6, 1905
Baldwin, Ernest Howard. Const. Engr., U. S. Reclamation Service, Ellensburg, Wash	Assoc. M. M.	May 4, 1898 Oct. 3, 1905
Baldwin, Fred Hixon. Supt., Bergenport Chemical Works, Bayonne, N. J		Nov. 5, 1884
Baldwin, George Porter. Real Estate Trust Bldg., Philadelphia, Pa		Feb. 5, 1908
Baldwin, Thomas Williams. 79 Clarkson St., Dorchester, Mass		April 2, 1884
Baldwin, Ward. Cons. Engr., 807 Commercial Tribune Bldg., Cincinnati, Ohio	Jun. M.	Mar. 2, 1881 Oct. 2, 1889
Baldwin, William Henry. Warburton Bldg., Yonkers, N. Y.		June 6, 1888
Baldwin, William James. Cons. Heating and Ventilating Engr., World Bldg., New York City		Sept. 5, 1888
Ball, Charles Backus. Chf. San. Insp., Dept. of Health, 215 Madison St. (Res., 4347 Hazel Ave.), Chicago, Ill		Oct. 1, 1890
Ballard, Robert. 35 Wood Lane, Shepherd's Bush, London, W., England		Sept. 1, 1880
Ballinger, Walter Francis. 1211 Arch St., Philadelphia, Pa.		Feb. 7, 1906
Barber, William Davis. Asst. Engr., Bureau of Eng., Dept. of Public Works, Chicago, Ill	Assoc. M. M.	Sept. 1, 1897 Jan. 8, 1902
Barbour, Frank Alexander. Hydr., San. and Cons. Engr., 1120 Tremont Bldg., Boston, Mass		Sept. 5, 1900
Barcroft, Frederick Thomas. Cons. Engr. and Archt., Suite 1728, Ford Bldg., Detroit, Mich		Sept. 3, 1902
Bard, George Parker. New York Mgr., Petroleum Iron Works Co., 50 Church St., New York City		April 6, 1909
Bardol, Frank Valentine Erhard. Engr. and Contr., 400 D. S. Morgan Bldg., Buffalo, N. Y		May 2, 1900
Barlow, John Quincy. Asst. Chf. Engr., Southern Pacific Co., 1120 Flood Bldg., San Francisco, Cal	Jun. M.	April 7, 1886 July 4, 1888

		Date of Membership.
Barnard, Edward Chester. Geographer, U. S. Geological Survey, Washington, D. C.		Dec. 3, 1902
Barnard, John Fiske. Ellendale Pl., Los Angeles, Cal.		Sept. 1, 1880
Barnes, Edward Harding. Chf. Engr., G. R. & I. Ry., Grand Rapids, Mich.		Dec. 5, 1906
Barnes, Mortimer Grant. Member, Advisory Board of Cons. Engrs. for the Impvt. of State Canals, State Hall, Albany, N. Y.	Assoc. M. M.	Nov. 2, 1898 May 31, 1904
Barnes, Thomas Howard. Care, United Fruit Co., 321 St. Charles St., New Orleans, La.		Oct. 4, 1899
Barnett, John William. City Engr., Athens, Ga.		Jan. 4, 1905
Barragan, Mariano Melerio. 3a de las Artes, No. 42, City of Mexico, Mexico		Feb. 5, 1908
Barrally, Thomas Webster. Div. Engr., Erie Canal, 45 Triangle Bldg., Rochester, N. Y.		Dec. 5, 1906
Barrows, Harold Kilbreth. Associate Prof. of Hydr. Eng., Mass. Inst. Tech.; (Barrows & Breed, Cons. Engrs.), 6 Beacon St., Boston, Mass.	Assoc. M. M.	Jan. 6, 1904 Mar. 31, 1908
Bascom, Harry Franklin. (Bascom & Sieger), 603 Allentown Bank Bldg., Allentown, Pa.	Jun. Assoc. M. M.	Dec. 5, 1899 Sept. 4, 1901 Mar. 2, 1909
Basinger, James Garnett. 52 Broadway, New York City	Assoc. M. M.	Oct. 3, 1900 April 30, 1907
Bassel, Robert. Regierungs und Bau-Rat, Lobauer Strasse 10, Deutsch-Eylau, Germany		May 2, 1888
Bassett, Carroll Phillips. Treas., Commonwealth Water & Light Co., Summit, N. J.		Nov. 7, 1888
Bassett, George Barclay. Pres. and Gen. Mgr., Buffalo Meter Co., Buffalo, N. Y.		Mar. 1, 1893
Bassett, John Benjamin. U. S. Asst. Engr., 914 Twenty-second St., Rock Island, Ill.		Dec. 1, 1908
BATES, ONWARD. (*Past-President*). 335 Dearborn St., Chicago, Ill.		Jan. 4, 1882
Baucus, William I. Engr. in Chg. of Surveys and Investigations for U. S. Intra-Coastal Waterways Canal from Boston to Narragansett Bay, U. S. Engr. Office, 25 Pemberton Sq., Boston, Mass.		Oct. 7, 1908
Bauer, Jacob Louis. 130 Broad St., Elizabeth, N. J.	Assoc. M. M.	Feb. 5, 1896 June 1, 1909
Baum, George. 520 Warburton Ave., Yonkers, N. Y.	Jun. Assoc. M. M.	Jan. 4, 1892 April 5, 1899 Mar. 6, 1906
Baxter, Frank Edwin. Vice-Pres., Baxter, Straw & Storrs Constr. Co., 1250 E. South Temple St., Salt Lake City, Utah		Oct. 2, 1901

		Date of Membership.
BAXTER, GEORGE STRONG. Railroad and lumber business. 15 William St., New York City	Jun. M.	May 12, 1875 May 3, 1876
BAYLISS, JOHN YANCEY. Prin. Asst. Engr., Madeira-Mamoré Ry. Co., Caixa 304, Manãos, Brazil	Assoc. M. M.	Sept. 2, 1903 Sept. 1, 1908
BAYLISS, RAWLINSON TENNANT. 11 Cornhill, London, E. C., England		June 4, 1890
BEACH, LANSING HOSKINS. Lt.-Col., Corps of Engrs., U. S. A., Room M, Custom House, New Orleans, La		June 7, 1905
BEACH, ROBERT JAMES. Pres., R. J. Beach Eng. Co., 32 Broadway, New York City		May 2, 1900
BEAHAN, WILLARD. First Asst. Engr., L. S. & M. S. Ry., Room 50, Lake Shore Bldg., Cleveland, Ohio		April 3, 1889
BEARD, EDWARD JAMES. 3928 McGee St., Kansas City, Mo		Feb. 7, 1900
BEARDSLEY, ARTHUR. Emeritus Prof. of Eng., Swarthmore Coll., Swarthmore, Pa	Assoc. M.	Sept. 1, 1875 Sept. 2, 1891
BEARDSLEY, JAMES WALLACE. Civ. Engr. with J. G. White & Co., Inc., 43 Exchange Pl., New York City		Dec. 4, 1901
BEATTIE, ROY HAMILTON. Engr. and Contr., 57 North Main St., Fall River, Mass		Oct. 5, 1909
BEATTY, PHILIP ASFORDBY. 3616 Fairview Ave., Forest Park, Baltimore, Md	Assoc. M. M.	Nov. 6, 1907 May 4, 1909
BECKWITH, FRANK. Asst. Engr., N. P. Ry., 210 Sixth St., S. E., Missoula, Mont		Nov. 7, 1900
BEELER, JOHN ALLEN. Vice-Pres. and Gen. Mgr., The Denver City Tramway Co., 617 Majestic Bldg., Denver, Colo		July 10, 1907
BEHREND, BERNARD ARTHUR. Advisory Engr., Westinghouse Elec. and Mfg. Co., and Engr. in Chg., Power Eng. Dept., P. O. Box 143, East Liberty, Pittsburg, Pa		Oct. 5, 1909
BELDEN, HARRY AUSTIN. 103 Cheapside, Baltimore, Md		Oct. 4, 1905
BELKNAP, JOHN MANSFIELD. Asst. Engr. of Bldgs., Terminal Engr.'s Office, N. Y. C. & H. R. R. R. Co., 335 Madison Ave., New York City	Assoc. M. M.	May 4, 1904 Mar. 31, 1908
BELKNAP, WILLIAM ETHELBERT. (*Director*). 294 West End Ave., New York City	Jun. Assoc. M. M.	Mar. 31, 1891 Mar. 6, 1895 Dec. 1, 1897
BELL, ALONZO CLARENCE. Chf. Engr., Board of Commrs. of the Port of New Orleans, 606 Hibernia Bank & Trust Co. Bldg., New Orleans, La		Mar. 7, 1900
BELL, ANDREW. Cons. Engr., Almonte, Ont., Canada		Sept. 5, 1883
BELL, GEORGE JOSEPH. County Surv. and Bridge Master, The Courts and 16 Portland Sq., Carlisle, England	Assoc. M. M.	Nov. 2, 1898 Oct. 1, 1902
BELL, GILBERT JAMES. Div. Engr., A., T. & S. F. Co., Marceline, Mo	Jun. M.	Sept. 7, 1887 Oct. 6, 1897
BELL, HENRY PURDON. Trent Canal, Campbellford, Ont., Canada		June 4, 1884

		Date of Membership.
Bell, James Richard. Hazeldene, Ightham, Kent, England		Sept. 2, 1896
Bellinger, Lyle Frederick. Civ. Engr., U. S. N., U. S. Navy Yard, Philadelphia, Pa		Nov. 6, 1901
Bellows, Oscar Francis. Res. Engr., Barge Canal, 43 Triangle Bldg., Rochester, N. Y.	Assoc. M. M.	Dec. 4, 1901 May 1, 1906
Bement, Robert Bunker Coleman. Cons. and Contr. Engr.; Pres., Robinson & Cary Co., St. Paul, Minn		Sept. 7, 1887
Benedict, Herschel Albert. Mech. and Elec. Engr., United Traction Co., Albany, N. Y		Mar. 2, 1909
Bennett, Frederick Wagoner. Cape May Court House, N. J.		Oct. 7, 1903
Bennett, Samuel Givens. 228 So. Ave. 66, Los Angeles, Cal.		Oct. 3, 1906
BENSEL, JOHN ANDERSON. (*President*). Commr., Board of Water Supply, 299 Broadway, New York City	Jun. M.	Sept. 2, 1885 Mar. 4, 1891
Benson, Orville. Plant Engr., Am. Bridge Co., East Berlin, Conn		June 5, 1901
Bent, Cornelius Conway Felton. Gen. Mgr., B. & O. S. W. Ry., Cincinnati, Ohio		May 1, 1889
Bentzon, Adrian Benoni. Civ. Engr. and Contr., Calle San Marcelo 320 altos, Lima, Peru	Assoc. M. M.	Mar. 6, 1901 Sept. 4, 1906
BENZENBERG, GEORGE HENRY. (*Past-President*). Cons. Engr., 1310 Wells Bldg., Milwaukee, Wis		May 2, 1883
Bergen, Van Brunt. Shore Rd. and 77th St., Brooklyn, N. Y		June 17, 1868
Berle, Kort. Cons. Engr., 11 East 24th St., New York City	Assoc. M. M.	Dec. 6, 1899 Nov. 4, 1903
Berquist, Axel Samuel Frederick. 1571 Forty-seventh St., Brooklyn, N. Y		June 6, 1906
Berry, George. Asst. Engr., Bureau of Highways, Municipal Bldg., Brooklyn, N. Y		May 3, 1905
Berry, John Bennington. Chf. Engr., C., R. I. & P. Ry. Co., La Salle Station, Chicago, Ill		May 4, 1909
Berry, Thomas. Hanford, Cal		July 1, 1908
Bettes, Charles Robert. Chf. Engr., Queens County Water Co., Far Rockaway, N. Y.	Jun. Assoc. M. M.	Oct. 1, 1890 June 7, 1893 June 1, 1909
Betts, Fred Keeler. Div. Engr., Board of Water Supply, New York City, 293 Wall St., Kingston, N. Y		May 4, 1898
Betts, Romeo Thompson. Asst. Engr., Dept., Docks and Ferries, Pier A, N. R., New York City.	Assoc. M. M.	Oct. 3, 1900 Feb. 2, 1909
Beugler, Edwin James. Civ. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	Jun. Assoc. M. M.	June 19, 1891 Feb. 1, 1899 Jan. 5, 1904
Biddle, John. Lt.-Col., Corps of Engrs., U. S. A., Chronicle Bldg., San Francisco, Cal		July 4, 1894
Biddle, William Foster. 2321 Spruce St., Philadelphia, Pa.		June 4, 1884

		Date of Membership.
Bienenfeld, Abel Morris. Chf. Engr., Associated Pipe Line Co., Wells-Fargo Bldg., 7th Floor, San Francisco, Cal....		Feb. 6, 1907
Bienenfeld, Bernard. Cons. Engr., 621 Wells-Fargo Bldg., San Francisco, Cal		May 6, 1903
Bigelow, Edward Manning. Pittsburg, Pa		Dec. 4, 1889
Billin, Charles Emery. 15 North Canal St., Chicago, Ill	Jun. M.	April 5, 1876 July 3, 1878
Billings, Asa White Kenney. Eng. Mgr., J. G. White & Co., Inc., 43 Exchange Pl., New York City	Assoc. M. M.	Dec. 5, 1906 Sept. 1, 1908
Binkley, George Holland. Engr., The Arnold Co., in Chg. of Boise-Owyhee Irrig. Project, Nyssa, Ore		Oct. 1, 1902
Bisbee, Fred Milton. Engr., Western Lines, A., T. & S. F. Ry., La Junta, Colo		May 3, 1899
Bishop, Hubert Keeney. First Deputy, N. Y. State Highway Comm., Albany, N. Y		Oct. 5, 1904
Bishop, William Israel. Pres., Bishop Constr. Co., Ltd., 3 Beaver Hall Sq., Montreal, Que., Canada	Assoc. M. M.	Feb. 6, 1901 Oct. 2, 1906
Bissell, Clinton Spencer. Asst. Engr., P. R. R. Co., Room 664, Broad St. Station, Philadelphia, Pa		May 6, 1908
Bissell, Frank Edward. Cons. Engr., 2185 East 93d St., Cleveland, Ohio	Jun. M.	April 2, 1884 Sept. 2, 1891
Bissell, Hezekiah. Cons. Engr., B. & M. R. R., Boston, Mass.		Sept. 15, 1869
Bixby, William Herbert. Col., Corps of Engrs., U. S. A., 428 Custom House, St. Louis, Mo		April 5, 1882
Black, Alexander Leslie. 323 Baronne St., New Orleans, La.		Dec. 4, 1907
Black, William Murray. Col., Corps of Engrs., U. S. A., Army Bldg., Whitehall St., New York City		June 6, 1888
Blackford, Francis Webster. Civ. and Min. Engr., Avenida del Cinco de Mayo No. 32, Cuarto No. 406, City of Mexico, D. F., Mexico		April 4, 1888
Blackwell, Francis Ogden. Cons. Engr., 49 Wall St., New York City		Oct. 5, 1904
Blake, Carroll. 154 Eightieth St., Brooklyn, N. Y	Assoc. M. M.	May 3, 1905 May 5, 1908
Blakeley, George Henry. Structural Engr., Bethlehem Steel Co., 727 Seneca St., South Bethlehem, Pa....	Jun. M.	Dec. 4, 1889 Oct. 2, 1895
Blakeslee, Clarence. Civ. Engr. and Contr. (C. W. Blakeslee & Sons), 58 Waverly St. (Res., 598 George St.), New Haven, Conn		June 4, 1895
Blanchard, Arthur Horace. Associate Prof. of Civ. Eng., Brown Univ.; Deputy Engr., State Board of Public Roads of Rhode Island, East Side Station, Providence, R. I	Jun. Assoc. M. M.	Jan. 2, 1900 April 5, 1905 May 4, 1909

		Date of Membership.
Bland, George Pierrepont. 510 Harrison Bldg., Philadelphia, Pa	Jun. M.	April 7, 1875 May 4, 1881
Bland, John Carlisle. Engr. of Bridges, Penn. Lines W. of Pitts., Union Station, Pittsburg, Pa	Jun. M.	May 12, 1875 June 4, 1879
Blauvelt, Louis David. Gen. Mgr. and Chf. Engr., The San Luis Southern Ry., Blanca, Colo		May 6, 1908
Blodgett, Albert Morrill. Pres., A. M. Blodgett Constr. Co., 1012 Commerce Bldg., Kansas City, Mo		Sept. 7, 1904
Bloom, J George. Pres., Southern Ballast Co., Lester, Okla		July 9, 1906
Bloss, Richard Parkhurst. Mechanicsville, N. Y		Jan. 6, 1904
Blossom, Francis. (Sanderson & Porter), 52 William St., New York City		Dec. 4, 1907
Blunt, William Titcomb. Supt., Subaqueous Rock Excavation, Balboa, Canal Zone, Panama		Oct. 5, 1898
Boardman, Charles Slauson. (Conkling & Boardman, Cons. Engrs.), 798 Ellicott Sq., Buffalo, N. Y		Mar. 2, 1909
Body, John Benjamin. 2a Puente de Alvarado 53, City of Mexico, D. F., Mexico	Assoc. M. M.	Oct. 2, 1895 May 2, 1900
Boecklin, Werner. Cons. Engr., Dongan Hills, Borough of Richmond, N. Y	Jun. Assoc. M. M.	Mar. 1, 1892 Dec. 1, 1897 Dec. 5, 1905
Bogart, John. Cons. Engr., 141 Broadway, New York City		Feb. 17, 1869
Boggs, Edward Marshall. Chf. Civ. Engr., Oakland Traction Co., San Fran., Oakland & San José Con. Ry., P. O. Box 496, Oakland, Cal		June 6, 1900
Boggs, Frank Cranstoun. Capt. Corps of Engrs., U. S. A.; Gen. Purchasing Officer, Isthmian Canal Comm., Washington, D. C		Nov. 8, 1909
Bogue, Virgil Gay. Vice-Pres. and Chf. Engr., West. Pac. Ry. Co., Mills Bldg., San Francisco, Cal		Sept. 15, 1869
Boller, Alfred Pancoast. Cons. Engr., 149 Broadway, New York City		Dec. 4, 1867
Bolton, Channing Moore. Cons. Engr., Rio, Albemarle Co., Va		Jan. 4, 1888
Bolton, Reginald Pelham. Cons. Engr., 527 Fifth Ave., New York City		Sept. 6, 1899
Bond, Edward Austin. State Hall, Albany, N. Y		Sept. 6, 1899
Bond, George Meade. Mech. Engr., 141 Washington St., Hartford, Conn		Feb. 2, 1887
Bonnyman, Alexander. Chf. Engr. and Gen. Mgr., Atlanta, Birmingham & Atlantic R. R., A., B. & A. R. R. Bldg., Atlanta, Ga		Nov. 4, 1908
Bontecou, Daniel. Cons. Engr., 406 Dwight Bldg., Kansas City, Mo		Nov. 5, 1879
Bonzano, Adolphus. Pres., Bonzano Rail Joint Co., 331 South 18th St., Philadelphia, Pa		Aug. 7, 1872

		Date of Membership.
Bonzano, Maximilian Ferdinand. Fort Totten, N. Y.		Jan. 6, 1886
Booth, George William. Hydr. Engr. with Comm. on Fire Prevention, National Board of Fire Underwriters, 135 William St., New York City	Assoc. M. M.	Sept. 7, 1904 Nov. 2, 1908
Booth, William Henry. Caxton House, Westminster, London, S. W., England		July 4, 1888
Boright, William Parsons. Chatham, N. Y.	Jun. Assoc. M. M.	Jan. 2, 1894 Mar. 1, 1899 Mar. 5, 1907
Bosler, Harry Sherman. Gen. Contr. (Bosler & Flynn), Chattanooga, Tenn		Feb. 4, 1903
Bott, John B. Engr., P. R. R., Greensburg, Pa		Oct. 1, 1890
Bowen, Oscar Sidney. Res. Engr., G. N. Ry. Co., Spokane, Wash		May 4, 1909
Bower, Charles Phillip. Pres. of C. P. Bower Constr. Co., Gen. Contrs., Bulletin Bldg., Philadelphia, Pa		June 5, 1907
Bowers, George. City Engr., City Hall, Lowell, Mass		Oct. 1, 1902
Bowie, Augustus Jesse. 102-A Bluff, Yokohama, Japan		Nov. 1, 1882
Bowker, Willard Lewis. Walpole, Mass		June 3, 1903
Bowman, Austin Lord. Civ. and Cons. Engr., 165 Broadway, Room 2611, New York City	Assoc. M. M.	Sept. 7, 1892 Dec. 1, 1897
Bowman, Charles Abel. Secy. and Treas., Morrison & Farrington, Inc., 514 Dillaye Bldg., Syracuse, N. Y		Nov. 1, 1905
Bowser, Edmund Hamilton. Chf. Timber Insp., Ill. Cent. R. R., 203 Rogers Bldg., Memphis, Tenn		June 1, 1904
Boyd, James Churchill. Cons. Mech. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	Jun. Assoc. M. M.	Sept. 3, 1895 May 1, 1901 Sept. 3, 1907
Boyd, William Charles. Asst. Engr., Pittsburg Rys. Co., 435 Sixth Ave., Pittsburg, Pa		Dec. 4, 1907
Boyden, Harry Chester. Asst. Engr., A., T. & S. F. Ry., Del Mar, Cal		June 3, 1908
Boynton, George Herbert. Pres., Gen. Constr. Co., McManus Bldg., Davenport, Iowa		Sept. 3, 1884
Brace, James Henry. Secy., Charles E. Fraser & Co., 1328 Broadway, New York City	Assoc. M. M.	Jan. 2, 1901 Sept. 6, 1904
Brackenridge, John Crosbie. Cons. Engr., 95 Liberty St., New York City		May 5, 1897
Brackenridge, William Algernon. Vice-Pres. and Gen. Mgr., Southern California Edison Co., Los Angeles, Cal		June 2, 1886
BRACKETT, DEXTER. (*Director*). Chf. Engr., Met. Water-Works, 1 Ashburton Pl., Boston, Mass		June 6, 1888
Bradbury, Edward Gatling. Civ. and San. Engr. (Bradbury & Shute), 605 New Hayden Bldg., Columbus, Ohio	Assoc. M. M.	Nov. 7, 1906 Aug. 31, 1909

		Date of Membership.
BRADFORD, WILLIAM. Cons. Engr., 909 Empire Bldg., Pittsburg, Pa		Dec. 7, 1898
BRADLEY, DANIEL EDWARD. Berlin, Conn		May 1, 1895
BRADLEY, FRANK EDWARD. 491 Fifth Ave., New York City		Feb. 6, 1907
BRADY, SAMUEL DUNLAP. Chf. Engr., Little Kanawha Syndicate Lines, Parkersburg, W. Va		Sept. 7, 1904
BRAINARD, OWEN. Cons. Engr.; Chf. Engr., Carrere & Hastings, Archts., 225 Fifth Ave., New York City		Oct. 3, 1906
BRAMWELL, GEORGE WASHINGTON. Cons. Engr., 335 Broadway, New York City		Mar. 1, 1893
BRANCH, ERNEST WILLIAM. Civ. and San. Engr., 947 Tremont Bldg., Boston, Mass		Sept. 6, 1905
BRAXTON, JAQUELIN MARSHALL. U. S. Asst. Engr., U. S. Engr. Office, Jacksonville, Fla	Jun. Assoc. M. M.	Jan. 5, 1897 May 3, 1899 Oct. 31, 1905
BRAZER, GEORGE HERBERT. (J. R. Worcester & Co., Cons. Engrs.), 79 Milk St., Boston, Mass	Assoc. M. M.	Nov. 1, 1905 April 6, 1909
BRECKINRIDGE, WILLIAM LEWIS. Engr., M. of W., C., B. & Q. R. R., 209 Adams St., Chicago, Ill		Oct. 7, 1903
BREEN, JOHN EDWARD. Prin. Asst. Engr., Bay Ridge Impvt., L. I. R. R., Church St., Richmond Hill, N. Y		May 1, 1907
R. BREITHAUPT, WILLIAM HENRY. (Keating & Breithaupt, Cons. Engrs.), 82 King St., East, Toronto, Ont., Canada	Jun. M.	June 4, 1884 July 6, 1887
BREMNER, GEORGE HAMPTON. Engr., Illinois Dist., C., B. & Q. R. R., 209 Adams St., Chicago, Ill		Dec. 6, 1899
BRENDLINGER, PETER FRANKLIN. Civ. Engr. and Contr., 1009 Arcade Bldg., Philadelphia, Pa		Sept. 7, 1887
BRENNEKE, WILLIAM GEORGE. (Brenneke & Fay, Cons. Civ. Engrs.), 1009 Fullerton Bldg., St. Louis, Mo	Assoc. M. M.	Mar. 5, 1902 Jan. 2, 1906
BREUCHAUD, JULES. Contr. Engr., 290 Broadway, New York City	Assoc. M.	June 5, 1889 Oct. 5, 1898
BREWER, BERTRAM. City Engr., Waltham, Mass		June 1, 1909
BREWSTER, HENRY BAUM. Cons. Engr., 517 S. A. & K. Bldg., Syracuse, N. Y	Assoc. M. M.	Mar. 6, 1907 Mar. 2, 1909
BRIGGS, BENJAMIN E. City Engr., City Hall, Erie, Pa		Nov. 4, 1908
BRIGGS, JOSIAH ACKERMAN. Chf. Engr. in and for the Borough of the Bronx, New York City		Sept. 1, 1886
BRIGGS, ROSWELL EMMONS. 3a San Juan de Letran 41, City of Mexico, D. F., Mexico		Sept. 15, 1869
BRIGGS, WALDO CLAYTON. Chf. Engr., Degnon Realty & Terminal Impvt. Co., Long Island City, N. Y		July 10, 1907
BRINCKERHOFF, ALEXANDER GORDON. Gen. Mgr., Johnson & Morris, 536 West 23d St., New York City (Res., 354 Jefferson Ave., Brooklyn, N. Y.)		Nov. 3, 1886

		Date of Membership.
Brinsmade, Daniel Seymour. Pres., The Ousatonic Water Co., Derby, Conn		Feb. 1, 1888
Britt, Dudley Digges. Civ. and Min. Engr., Clarksburg, W. Va.		April 1, 1908
Brohm, William Carl. Chf. Engr., Grainger & Co. Iron Works, 100 Tenth St., Louisville, Ky		Feb. 1, 1905
Brooks, Frederick. Secy., Assoc. Eng. Societies, 31 Milk St., Boston, Mass	Jun. M.	June 7, 1876 Jan. 2, 1884
Brown, Baxter Lamont. 610 Merchants-Laclede Bldg., St. Louis, Mo		April 1, 1903
Brown, Charles Carroll. Cons. Engr.; Editor, *Municipal Engineering Magazine*, 408 Commercial Club Bldg., Indianapolis, Ind		Oct. 2, 1895
Brown, Charles Otto. Cons. Engr., 624 Madison Ave., New York City	Jun. M.	Jan. 6, 1875 Nov. 7, 1877
Brown, Earl Ivan. Capt., Corps of Engrs., U. S. A., U. S. Engr. Office, Wilmington, N. C		Feb. 2, 1909
Brown, Le Grand. 34 Ellis St., San Francisco, Cal		May 4, 1898
Brown, Linus Weed. Monrovia, Cal		June 7, 1899
Brown, Louis Livingston. Gen. Supt., The Foundation Co., 115 Broadway, New York City		May 3, 1905
Brown, Maurice Fritchley. Chf. Engr., Boston Bridge Works, 47 Winter St., Boston, Mass. .	Assoc. M. M.	Mar. 4, 1903 Feb. 28, 1905
Brown, Norman Freed. 427 Atlantic Ave., Pittsburg, Pa	Assoc. M. M.	June 5, 1907 Nov. 30, 1909
Brown, Paul Goodwin. Managing Engr., The United Eng. and Contr. Co., 17 West 42d St., New York City		May 2, 1906
Brown, Perry Fisher. 300 Park View Terrace, Oakland, Cal. .		June 3, 1908
Brown, Ralph Henry. Chf. Engr., Eastern Bridge & Structural Co., Station A, Worcester, Mass		June 7, 1899
Brown, Robert Calvin. Evergreen Ave., Plainfield, N. J		Dec. 5, 1906
Brown, Thomas Ellis. Cons. Engr., Otis Elevator Co., 17 Battery Pl., New York City	Jun. M.	Nov. 3, 1880 April 2, 1884
Brown, Wendell Phillips. Eastern Representative, King Bridge Co., 30 Church St., New York City	Assoc. M. M.	Oct. 2, 1895 Mar. 5, 1902
Brown, William Gerrie. Cons. Engr., Chamber of Commerce, Portland, Ore		Nov. 7, 1906
Brown, William Lowe. Engr. of Underground Extension, Buenos Aires Western Ry., care Señor Don A. F. Lertora, Casilla No. 741, Ferro Carril Del Oeste, Buenos Aires, Argentine Republic	Assoc. M. M.	Sept. 6, 1905 Oct. 1, 1907
Brown, William Maxwell. Chf. Engr., Met. Sewerage Works, 1 Ashburton Pl., Boston, Mass		Feb. 5, 1896
Browne, George Hamilton. Hawkwood, Zion, Louisa Co., Va.		Sept. 3, 1884

		Date of Membership.
BROWNE, JAMES SIMPSON. Div. Engr., N. Y., N. H. & H. R. R., 409 Union Station, Providence, R. I.	Assoc. M. M.	Oct. 4, 1893 July 1, 1909
BROWNE, WILLIAM ROBERT. Bethany Beach, Sussex Co., Del.		June 1, 1898
BROWNELL, ERNEST HENRY. Civ. Engr., U. S. N., Naval Station, Cavite, Philippine Islands	Assoc. M. M.	Jan. 1, 1896 Jan. 5, 1904
BROWNING, GEORGE ELLIOT. Chf. Engr., Cochin Govt., Rose Bank, Trichur, South India	Assoc. M. M.	May 7, 1902 April 4, 1905
BROWNLEE, JAMES LEEMAN. Cons. Engr., 114 Liberty St., New York City		May 6, 1896
BRUCE, FRED WILLIAM. U. S. Asst. Engr., South Jacksonville, Fla.		April 4, 1900
BRUMLEY, DANIEL JOSEPH. Prin. Asst. Engr., Ill. Cent. R. R. Co., 1 Park Row, Chicago, Ill.		June 3, 1908
BRUNNER, JOHN. Asst. Gen. Supt., North Works, Illinois Steel Co., 1319 Wabansia Ave., Chicago, Ill.		Mar. 2, 1898
BRYAN, CHARLES WALTER. Div. Contr. Mgr., Am. Bridge Co. of N. Y., 30 Church St., New York City		June 3, 1903
BRYAN, FRED ASDEL. Gen. Mgr., Ind. & Mich. Elec. Co., 220 Colfax Ave., South Bend, Ind.		Dec. 1, 1908
BRYDONE-JACK, ERNEST EDMUND. Prof. of Civ. Eng., Univ. of Manitoba, Winnipeg, Man., Canada	Assoc. M. M.	Oct. 4, 1899 Oct. 6, 1908
BRYSON, ANDREW. Pres., Brylgon Steel Casting Co., New Castle, Del.		April 1, 1885
BUCHANAN, EDWARD EVERETT. Cons. Bridge Engr., Elmira, N. Y.		Dec. 4, 1889
BUCHHOLZ, CARL WALDEMAR. Cons. Engr., Erie R. R., 50 Church St., New York City		Sept. 1, 1886
BUCK, HENRY ROBINSON. (Buck & Sheldon, Inc., San. and Structural Engrs.), 36 Pearl St., Hartford, Conn.	Jun. Assoc. M. M.	June 5, 1900 Oct. 4, 1905 Feb. 4, 1908
R. BUCK, RICHARD SUTTON. (Sanderson & Porter), 52 William St., New York City	Assoc. M. M.	April 5, 1893 Mar. 2, 1898
BUCK, WALDO EMERSON. Pres. and Treas., Worcester Mfrs. Mutual Insurance Co., 31 Institute Rd., Worcester, Mass.		July 3, 1889
BUDGE, EDWARD BARNARD. Engr. in Chf., 1st Section, Chili State Rys., Chacabuco St. No. 13, Valparaiso, Chili		Nov. 6, 1901
BUDGE, ENRIQUE. Hôtel des Champs Elysées, 3 rue Balzac, Paris, France		Feb. 1, 1882
BUEHLER, WALTER. Vice-Pres., Kettle River Quarries Co., Minneapolis, Minn.; Address, 6182 Washington Blvd., St. Louis, Mo.	Assoc. M. M.	Mar. 7, 1906 Jan. 4, 1910
BUFFINTON, BENJAMIN THOMAS. 22 Bedford St., Fall River, Mass.	Assoc. M. M.	Sept. 7, 1904 Jan. 3, 1907
BULL, GEORGE MAIRS. Cons. Engr., Denver, Colo.		Feb. 2, 1909

		Date of Membership.
Bullock, William Dexter. Asst. Engr. in Chg., Bridges and Harbor, City Engr.'s Office, Providence, R. I.	Jun. M.	Sept. 5, 1887 July 4, 1888
Burbank, George Barker. 15 Wall St., New York City		July 4, 1888
Burden, James. Res. Engr., New York State Barge Canal, 3 Locust Ave., Troy, N. Y.	Assoc. M. M.	Feb. 5, 1902 Jan. 5, 1904
Burdett, Frederick Anderson. Cons. Engr., 29 West 34th St., New York City	Jun. Assoc. M. M.	Feb. 2, 1897 June 1, 1898 Oct. 7, 1903
Burgess, Alfred Samuel. Asst. Engr., New York Aqueduct Comm., 280 Broadway (Res., 1822 Anthony Ave.), New York City		Sept. 6, 1905
Burgess, George Heckman. Chf. Engr., The Delaware & Hudson Co., Albany, N. Y.	Jun. Assoc. M. M.	Feb. 1, 1898 June 3, 1903 July 1, 1909
Burgess, Harry. Maj., Corps of Engrs., U. S. A., 3338 St. Charles Ave., New Orleans, La.		Oct. 5, 1909
Burke, John Thomas. Caldwell, Idaho	Assoc. M. M.	Nov. 1, 1905 Oct. 6, 1908
Burke, Milo Darwin. 18 East Fourth St., Cincinnati, Ohio		July 4, 1894
Burley, Harry Benjamin. 586 Newton St., Chestnut Hill, Brookline, Mass.		Mar. 4, 1908
Burns, Clinton Sumner. Civ., Hydr. and San. Engr., 823 Scarritt Bldg., Kansas City, Mo.	Assoc. M. M.	Feb. 1, 1899 Jan. 3, 1905
Burns, Edward Cook. 417 Spring St., Jamestown, N. Y.		July 5, 1882
Burpee, Moses. Chf. Engr., Bangor & Aroostook R. R., Houlton, Me.		Sept. 3, 1884
Burr, Edward. Lt.-Col., Corps of Engrs., U. S. A., 25 Pemberton Sq., Boston, Mass.		May 6, 1891
Burr, William Hubert. Prof. of Civ. Eng., Columbia Univ.; Cons. Engr., 151 West 74th St., New York City	Jun. Assoc. M.	June 3, 1874 May 5, 1880 Mar. 3, 1886
Burrowes, Harry Gilbert. Div. Engr., Hudson & Manhattan R. R. Co., 124 West 31st St., New York City	Jun. Assoc. M. M.	Sept. 2, 1902 Feb. 3, 1904 July 1, 1909
Burt, Henry Jackson. Contr. Mgr., Am. Bridge Co. of N. Y., 235 Equitable Bldg., Denver, Colo.		Mar. 1, 1905
Burton, Alfred Edgar. Dean and Prof. of Topographical Eng., Mass. Inst. Tech., Boston, Mass.		Sept. 4, 1901
Bush, Edward Wallace. Chf. Engr., Saybrook and Lyme Conn. River Bridge Comm., Saybrook, Conn.	Assoc. M. M.	April 5, 1899 April 30, 1907
Bush, Harry Dean. Vice-Pres. and Mgr., Baltimore Bridge Company, Baltimore, Md.		May 2, 1888
Bush, Lincoln. Cons. Engr., 1 Madison Ave., New York City.		Oct. 4, 1905

		Date of Membership.
Butler, Matthew Joseph. Vice-Pres. and Gen. Mgr., Dominion Iron & Steel Co., Ltd., Dominion Coal Co., Ltd., Sydney, N. S., Canada		April 1, 1885
Butterfield, Francis Eaves. Culiacan, Sinaloa, Mexico		Sept. 1, 1886
Butts, Edward Pontany. Chf. Engr., Am. Writing Paper Co., Holyoke (Res., Springfield), Mass.	Assoc. M. M.	Feb. 2, 1898 Oct. 7, 1903
Byam, Le Roy Henry. Asst. Engr., N. Y. C. & H. R. R. R. Co., 335 Madison Ave., New York City (Res., Edgecliff Terrace, Park Hill, Yonkers, N. Y.)		July 1, 1908
Byers, Alexander Mosby Clayton. Supt., M. W., B. and B., Tehuantepec National Ry., Rincon Antonio, Oax., Mexico		Nov. 6, 1907
C. **Byers, Morton Lewis.** Chf. Engr., M. of W., Mo. Pac. System, Cor. 4th and Market Sts., St. Louis, Mo.	Jun. M.	Jan. 2, 1890 Sept. 7, 1898
Byllesby, Henry Manson. Pres., H. M. Byllesby & Co. (Inc.), Engrs., Am. Trust Bldg., Chicago, Ill		June 1, 1887
Cahill, Walter John. Chf. Engr. and Second Vice-Pres., Great Lakes Dredge & Dock Co., Chamber of Commerce (Res., 1030 E. 47th St.), Chicago, Ill		June 6, 1906
Cain, William. Prof. of Math., Univ. of North Carolina, Chapel Hill, N. C.		Nov. 7, 1888
Cairns, Robert Andrew. City Engr., Waterbury, Conn		Oct. 2, 1895
Calderwood, Isaac Glidden. Massena, N. Y		June 1, 1909
Caldwell, George Bowers. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City (Res., 54 Van Sice Ave., Yonkers, N. Y.)		April 1, 1908
Caldwell, William Howell. Room 501, Curry Bldg., Tampa, Fla		May 4, 1909
Callaghan, John. Box 1603, Edmonton, Alberta, Canada		Oct. 3, 1906
Camp, Walter Mason. Chf. Editor, *Railway and Engineering Review*, 7740 Union Ave., Chicago, Ill		May 1, 1901
Campbell, John Logan. Engr., M. of W., El Paso & Southwestern R. R., El Paso, Tex		May 1, 1901
Campen, George Linden. Asst. City Engr., Omaha, Nebr		Oct. 5, 1909
Campion, Horace Thomas. Pres., The Campion McClellan Co., 1218 Chestnut St., Philadelphia, Pa		July 1, 1909
Canals, José Antonio. Civ. Engr. and Archt., 16 Tetuan St., San Juan, Porto Rico		May 3, 1905
Canfield, Edward. Gen. Supt., N. Y., O. & W. Ry., Middletown, N. Y		Dec. 3, 1879
Cannon, Madison Mott. Care, W. L. Miller, 19 Milk St., Boston, Mass		Jan. 2, 1907
Cantine, Edward Ike. Div. Engr., D., L. & W. Ry., 77 Watson Ave., East Orange, N. J		May 3, 1905

		Date of Membership.
APLES, MARTIN JOSEPH. Vice-Pres. and Gen. Mgr., Carolina, Clinchfield & Ohio Ry., Johnson City, Tenn.	Assoc. M. M.	Nov. 4, 1891 Oct. 4, 1899
APPELEN, FREDERICK WILLIAM. Chf. Engr. and Gen. Mgr., Decarie Incinerator Co., Hopkins, Minn.		April 3, 1895
ARLILE, THOMAS JENKS. Prin. Asst. Engr., L. I. R. R., Jamaica, N. Y.	Jun. Assoc. M. M.	Mar. 3, 1896 Mar. 6, 1901 Dec. 3, 1907
ARLL, DAVID SYLVANUS. Second Vice-Pres. and Gen. Mgr., Capital Traction Co., Washington, D. C.	Jun. Assoc. M. M.	Mar. 7, 1888 July 1, 1891 Oct. 7, 1896
ARMALT, LAURANCE JOHNSON. With Baldwin Eng. Co., 209 West 33d St., New York City		May 1, 1907
ARPENTER, ALLAN WADSWORTH. Engr. of Structures, N. Y. C. & H. R. R. R., 7th Floor, Grand Central Palace, New York City (Res., 68 Arthur St., Yonkers, N. Y.)	Jun. Assoc. M. M.	Mar. 5, 1901 April 1, 1903 Sept. 1, 1908
ARPENTER, CHARLES LINCOLN. Supt. of Constr., J. G. White & Co., Inc., and Gen. Mgr., Cuba Eastern R. R., Guantanamo, Cuba		Dec. 6, 1905
ARPENTER, GEORGE ANSEL. City Engr., Pawtucket, R. I.		May 7, 1902
ARR, ALBERT. 68 Carnegie Ave., East Orange, N. J.	Assoc. M. M.	Mar. 2, 1892 Oct. 7, 1903
ARR, WALTER FRANK. Chf. Engr., The Falk Co., Milwaukee, Wis.		June 6, 1894
ARROLL, EUGENE. Chf. Engr. and Mgr., Butte Water Co., Butte, Mont.	Jun. Assoc. M. M.	Jan. 4, 1888 July 1, 1891 June 2, 1897
ARSON, HOWARD ADAMS. Cons. Engr., 79 Glenwood St., Malden, Mass.		Feb. 7, 1894
ARSON, WILLIAM WALLER. Prof. of Civ. Eng., Univ. of Tennessee, 1705 Clinch Ave., Knoxville, Tenn.		Nov. 2, 1892
ARTER, EDWARD CARLOS. Chf. Engr., C. & N. W. Ry., Chicago, Ill.		April 4, 1888
ARTER, HENRY HALL. Pres., Met. Contr. Co., and Cons. Engr., 95 Milk St., Boston, Mass.		May 7, 1890
ARTER, J. RIVERS. Birmingham, Ala.		Feb. 3, 1892
ARTER, SHIRLEY. Asst. Engr., U. S. Engr. Dept., Norfolk, Va.	Jun. Assoc. M. M.	May 31, 1892 Oct. 5, 1898 Dec. 4, 1906
ARTER, WILLIAM J. Cons. Engr., 1315 Rockefeller Bldg., Cleveland, Ohio	Jun. Assoc. M. M.	Feb. 5, 1895 Sept. 7, 1898 Nov. 1, 1904
ARTLIDGE, CHARLES HOPKINS. Bridge Engr., C., B. & Q. R. R., 209 Adams St., Chicago, Ill.		May 4, 1904

		Date of Membership
CARY, EDWARD RICHARD. Prof. of Geodesy and Railroad Eng., Rensselaer Polytechnic Inst., Troy, N. Y.		April 2, 1902
CASE, JAMES FRANCIS. Director of Public Works, and Chf. Engr., Dept. of Sewer and Waterworks Constr., Manila, Philippine Islands		Jan. 6, 1904
CATTELL, WILLIAM ASHBURNER. Cons. Engr., Foxcroft Bldg., San Francisco, Cal	Assoc. M. M.	May 6, 189 Oct. 7, 189
CHADBOURN, WILLIAM HOBBS, JR. Prin. Asst. Engr., Chic. Gt. West. R. R., Room 463, Grand Central Station, Chicago, Ill	Jun. M.	Dec. 3, 189 Mar. 1, 1905
CHAMBERLAIN, PHILLIP WILLIAM. Mgr., Chamberlain & Xirinachs, Guapiles, Costa Rica		Oct. 2, 1895
CHAMBERLIN, CHESTER HARVEY. Asst. Chf. Engr., Tex. & Pac. Ry., Dallas, Tex		Oct. 5, 1904
CHAMBERS, FRANK TAYLOR. U. S. Naval Coal Depot, California City Point, Tiburon, Cal	Assoc. M. M.	April 6, 1898 Mar. 3, 1903
CHAMBERS, RALPH HAMILTON. (Chambers & Hone), 1 Liberty St., New York City	Assoc. M. M.	Dec. 1, 1897 April 5, 1904
R. CHANUTE, OCTAVE. (*Past-President*). Cons. Engr., 1138 Dearborn Ave., Chicago, Ill	M. F.	Feb. 19, 1868 July 11, 1872
CHAPIN, LOOMIS EATON. Cons. Engr., 14 Central Savings Bank Bldg., Canton, Ohio	Jun. Assoc. M. M.	Dec. 3, 1884 Sept. 7, 1892 Nov. 4, 189
CHAPLEAU, SAMUEL JEFFERSON. Res. Engr., Public Works Dept., Ottawa, Ont., Canada	Assoc. M. M.	May 1, 190 Jan. 31, 1905
CHAPMAN, JAMES RUSSELL. Gen. Mgr. and Chf. Engr., Underground Elec. Rys. Co. of London, Ltd., Electric Ry. House, Broadway, Westminster, London, S. W., England		Mar. 6, 1901
CHAPPELL, THOMAS FENNING. 215 West 125th St., Room 51, New York City		Oct. 5, 1904
CHASE, CHARLES FRANCIS. Cons. Engr., 75 Westminster St., Providence, R. I.		Jan. 1, 189
CHASE, CHARLES FRANCIS. Chf. Engr., Berlin Constr. Co., Berlin (Res., 241 West Main St., New Britain), Conn		Feb. 5, 1902
CHASE, FRANK LYNTON. Pres., The Central Contract & Finance Co., 821 Columbus Savings & Trust Bldg., Columbus, Ohio	Assoc. M. M.	Nov. 4, 189 Nov. 1, 1899
CHASE, JOHN CARROLL. Cons. Engr., Derry Village, N. H.		Mar. 1, 1893
CHASE, MARVIN. Superv. Engr., Okanogan Irrig. & Power Co., Edmonds, Wash		June 5, 1907
CHEEVER, ALBERT SAFFORD. Supt., Fitchburg Div., B. & M. R. R., Boston, Mass.		June 7, 1893
CHENEY, HERBERT NEAL. Engr. in Chg., Calf Pasture Station, Boston Consol. Gas Co., 212 Savin Hill Ave., Dorchester, Mass.	Assoc. M. M.	Feb. 6, 1907 Sept. 1, 1908

		Date of Membership.
Chester, John Needels. Gen. Mgr., Sales, Epping-Carpenter Co., Pittsburg, Pa.	Jun. Assoc. M. M.	Dec. 6, 1892 Dec. 5, 1894 Mar. 6, 1901
Chibas, Eduardo Justo. Cons. Engr. and Contr., Marina alta 4, Santiago de Cuba, Cuba	Jun. Assoc. M. M.	Mar. 31, 1891 May 6, 1896 Jan. 3, 1900
Child, Stephen. 15 Ashburton Pl., Room 511, Boston, Mass.		Oct. 5, 1898
Childs, James Edmund. Vice-Pres. and Gen. Mgr., N. Y., O. & W. Ry., 56 Beaver St., New York City		Dec. 4, 1878
Childs, Oliver W. City Bridge Engr., City Hall, St. Louis, Mo	Assoc. M. M.	Sept. 5, 1900 Sept. 3, 1902
Chipman, Willis. 103 Bay St., Toronto, Ont., Canada		June 6, 1888
Chittenden, Hiram Martin. Lt.-Col., Corps of Engrs., U. S. A., 124 Fifteenth Ave., N., Seattle, Wash		Feb. 7, 1900
Choate, Joseph Kittredge. Gen. Mgr., Otsego and Herkimer R. R., Cooperstown, N. Y		May 4, 1909
Christian, George Lyon. Asst. Engr., Bureau of Sewers, Borough of the Bronx, East 177th St. and 3d Ave. (Res., East 238th St., Woodlawn), New York City	Assoc. M. M.	Mar. 6, 1895 Oct. 3, 1905
Christie, George B. (Christie & Lowe, Civ. Engrs. and Contrs.), 171 La Salle St., Chicago, Ill		Oct. 2, 1895
Christie, James. Cons. Engr., 100 Rochelle Ave., Wissahickon, Philadelphia, Pa		May 7, 1873
Christie, William Wallace Cons. Engr., Citizens Trust Bldg., Paterson, N. J.		June 3, 1908
Christy, George Lewis. 128 West 42d St., New York City	Jun. Assoc. M. M.	June 6, 1893 Nov. 4, 1896 Jan. 31, 1905
Church, Charles Titus. 155 William St., Geneva, N. Y.		May 1, 1889
Church, Fred Bush. 10 Bridge St., New York City		June 3, 1908
Church, William Lee. Pres. and Cons. Engr., Ambursen Hydr. Constr. Co., 176 Federal St., Boston, Mass		Feb. 6, 1907
CHURCHILL, CHARLES SAMUEL. (*Director*). Chf. Engr., Norfolk & West. Ry., Roanoke, Va		May 1, 1889
Churchill, John Charles. U. S. Asst. Engr., Oswego, N. Y.		Feb. 1, 1899
Clapp, Joseph Malcolm. Prin. Asst. Engr., U. S. Engr. Office, P. O. Box 1809, Seattle, Wash		Nov. 4, 1908
Clapp, Otis Francis. City Engr., City Hall, Providence, R. I.		Mar. 2, 1898
Clapp, William Billings. Engr., U. S. Geological Survey, in Chg. of Water Resources Investigations in California, 214 Boston Bldg., Pasadena, Cal		Dec. 6, 1905
Clark, Charles Henry. Engr., M. of W., Cleveland Rys., Cleveland, Ohio		May 7, 1902

		Date of Membership
Clark, George Hallett. 105 West 54th St., New York City	Jun. Assoc. M. M.	Oct. 3, 189 April 6, 189 Oct. 31, 190
Clark, Roscoe Nathaniel. Asst. City Engr., 800 Main St., Hartford, Conn.	Assoc. M. M.	May 4, 190 Mar. 5, 190
Clark, Thomas Stevens. Chf. Engr., Alphons Custodis Chimney Cons. Co., 622 Bennett Bldg., New York City		June 3, 190
Clark, Watson Gerould. Tenafly, N. J.		July 9, 190
Clarke, David Dexter. Engr., Water Board, Portland, Ore.		July 5, 188
N. Clarke, Eliot Channing. 15 Brimmer St., Boston, Mass.		Sept. 4, 187
Clarke, Ernest Wilder. Asst. Engr., Board of Water Supply, City of New York, Valhalla, N. Y.		Jan. 4, 190
Clarke, George Calbraith. Penn. Terminal, 32d St. and 7th Ave., New York City		June 3, 190
Clarke, St. John. Bogota, N. J.	Jun. M.	Sept. 5, 188 June 1, 190
Clarke, Thomas Curtis. Care, Lackawanna Steel Co., 2 Rector St., New York City		May 4, 190
Clarkson, Robert Cooke. Care, Chas. E. Monday & Co., 1320 Olive St., Philadelphia, Pa.	Jun. M.	Jan. 5, 188 Jan. 2, 190
Claussen, Oscar. Cons. Engr., National German Am. Bank Bldg., St. Paul, Minn.		Oct. 2, 190
Clayton, Robert Morris. City Engr., Atlanta, Ga.		Mar. 4, 189
Clayton, Thomas Wiley. Engr. of Maintenance, South Side Elev. R. R., 47 Congress St., Chicago, Ill.		Nov. 6, 190
Clement, Frank Hudson. Engr. and Contr., Land Title Bldg., Philadelphia, Pa. (Res., 124 West 48th St., New York City)		Nov. 1, 188
Clermont, John Baptiste. Engr. of Bldg. Constr. with the Hedden Constr. Co.; Supt. of the Constr. of the Met. Life Insurance Bldg. and Tower, 1 Madison Ave., New York City	Assoc. M. M.	May 4, 190 Oct. 6, 190
Coane, John Montgomery. 70 Queen St., Melbourne, Victoria, Australia		Nov. 4, 190
Code, William Henry. Chf. Engr., U. S. Indian Service, 522 Bumiller Bldg., Los Angeles, Cal.		June 5, 190
Codwise, Edward Bertie. 298 Wall St., Kingston, Ulster Co., N. Y.		Sept. 5, 188
Coe, David. Care, S. Pearson & Son, Sucrs., Apartado 54, Vera Cruz, Mexico		Sept. 7, 190
Coe, William Watson. Gen. Mgr., Pocahontas Coal & Coke Co., Roanoke, Va.		April 3, 188
Coffin, Amory. 362 South Orange Ave., South Orange, N. J.		Mar. 3, 187
Coffin, Thomas Amory. Engr. and Contr., 45 Broadway, New York City	Jun. M.	Oct. 2, 189 Feb. 1, 189

		Date of Membership.
Cogswell, William Brown. Vice-Pres. and Managing Director, The Solvay Process Co., Syracuse, N. Y.	Assoc. M.	Feb. 15, 1871 Oct. 16, 1872
Cohen, Frederick William. Engr. of Erection, Bridge and Constr. Dept., The Pennsylvania Steel Co., Steelton, Pa.	Assoc. M. M.	Feb. 3, 1897 Sept. 3, 1902
COHEN, MENDES. (*Past-President*). 825 N. Charles St., Baltimore, Md.		Dec. 4, 1867
Colby, Albert Ladd. Cons. Engr., and Iron and Steel Metallurgist, 447 Lehigh St., South Bethlehem, Pa.		Oct. 7, 1903
Colby, Branch Harris. Cons. Engr., 812 Security Bldg., St. Louis, Mo.		June 5, 1895
Cole, Daniel Webster. Const. Engr., Shoshone Dam, Cody, Wyo.		June 7, 1905
Cole, Howard Judson. 11 High St., Morristown, N. J.	Assoc. M. M.	Jan. 6, 1892 Mar. 1, 1899
Cole, John Adams. Cons. Engr., 310 Ashland Blk., Chicago, Ill.		Mar. 7, 1894
Cole, William Weeden. Mgr. of Utilities Dept., Dodge & Day, 608 Chestnut St., Philadelphia, Pa.		Oct. 7, 1903
Coleman, Clarence. U. S. Asst. Engr., Engr. Office, U. S. A., Duluth, Minn.		Nov. 3, 1897
Coleman, Frederick Albert. Pres., The J. D. Smith Foundry Supply Co., 1846 Scranton Rd., Cleveland, Ohio	Jun. Assoc. M. M.	April 4, 1893 April 5, 1899 Dec. 1, 1903
Coleman, John Francis. Cons. Engr., 920 Hibernia Bldg., New Orleans, La.		Oct. 2, 1901
Collier, Bryan Cheves. Engr. for J. C. Rodgers, 121 West 125th St. (Res., 2721 Bainbridge Ave.), New York City	Assoc. M. M.	Oct. 3, 1900 June 4, 1907
Collingwood, Francis. Cons. Engr., Elizabeth, N. J.; Office address 220 West 57th St., New York City		Mar. 3, 1869
Collins, Daniel Charles Newman. Cons. Engr., 29 Broadway, New York City		April 3, 1901
Collins, Roderick Greene, Jr. Chf. Engr., New York Contr. Co., 215 West 33d St., New York City		May 4, 1904
Colpitts, Walter William. Chf. Engr., K. C., M. & O. Ry. Co., 406 U. S. & Mex. Trust Bldg., Kansas City, Mo.		Nov. 1, 1905
Compton, Charles Sumner. Pres., Sierra Poly. Inst.; Cons. Engr., North. Elec. Ry. Co., Orloff, Butte Co., Cal.		June 3, 1908
Comstock, Charles Worthington. Cons. Engr., Boston Bldg., Denver, Colo.	Jun. Assoc. M. M.	April 5, 1892 Feb. 7, 1900 Sept. 5, 1905
Conard, Clarence Knight. Asst. Engr., Erie R. R. Co., 50 Church St., Room 977, New York City		Oct. 5, 1909
Condron, Theodore Lincoln. Cons. Bridge and Structural Engr., 1214 The Monadnock, Chicago, Ill.	Assoc. M. M.	Feb. 1, 1899 Oct. 2, 1901

		Date of Membership.
Conkling, Cloud Clifford. Cons. Civ. Engr., 798 Ellicott Sq. Bldg., Buffalo, N. Y.		Jan. 4, 1905
Conn, Frank Winslow. Care, Hammond Mfg. Co., 54 First St., Portland, Ore		June 1, 1904
Connett, Albert Neumann. Chf. Engr., J. G. White & Co., Ltd., 9 Cloak Lane, London, E. C., England	Jun. M.	June 6, 1883 Oct. 1, 1890
Connor, Edward Hanson. Vice-Pres., Mo. Val. Bridge & Iron Co., Leavenworth, Kans	Jun. Assoc. M. M.	Feb. 5, 1890 Feb. 3, 1892 April 4, 1900
Connor, Samuel Powers. 230 West 107th St., New York City	Assoc. M. M.	Nov. 7, 1906 Jan. 7, 1908
Constable, Howard. Archt., Lyons Falls, Lewis Co., N. Y.		Dec. 7, 1892
Constant, Frank Henry. Prof. of Structural Eng., Univ. of Minnesota, Minneapolis, Minn.	Assoc. M. M.	Dec. 2, 1896 April 2, 1907
Contri, Silvio. Archt., 1a General Prim 15, City of Mexico, Mexico		July 1, 1908
Conway, George Robert Graham. Chf. Engr., Monterrey Ry., Light & Power Co., Ltd., and Monterrey Waterworks & Sewer Co., Ltd., Apartado 291, Monterey, N. L., Mexico		Dec. 4, 1907
Cook, Frederick Scott. Div. Engr., Croton Falls Reservoir, The Aqueduct Commrs., 280 Broadway, New York City (Res., Yonkers, N. Y.)		June 3, 1908
Cook, John Henry. Hydr. Engr., Society for Establishing Useful Manufactures, 158 Ellison St., Paterson, N. J	Assoc. M. M.	May 4, 1898 Jan. 4, 1910
Cooley, Lyman Edgar. 21 Quincy St., Chicago (Res., Evanston), Ill		June 1, 1898
Cooley, Maurice Wurtz. Gen. Mgr., Uintah Ry., Mack, Colo	Assoc. M. M.	Mar. 7, 1894 Dec. 3, 1902
Coombs, Philip Henry. Civ. Engr. and Surv., 37 Exchange Blk., 25 State St., Bangor, Me		Mar. 7, 1906
Coombs, Robert Duncan. Engr. and Contr. (Fitzpatrick & Coombs), 1123 Broadway, New York City	Jun. Assoc. M. M.	May 2, 1899 Feb. 7, 1900 Jan. 7, 1908
Coombs, Stephen Elbridge. 335 Madison Ave., Room 1101, New York City		Sept. 3, 1902
Cooper, Hugh Lincoln. Cons. Engr. (Cooper & Powelson), 60 Wall St., New York City		Sept. 6, 1905
Cooper, Samuel Lispenard. City Engr., Yonkers, N. Y.		Feb. 6, 1889
N. N. Cooper, Theodore. 45 Broadway, New York City		Mar. 4, 1874
Cornell, George Birdsall. 67 Montclair Ave., Montclair, N. J	Jun. M.	Aug. 6, 1879 Oct. 6, 1886
Cornell, John Nelson Hayward. 60 Wall St., New York City	Jun. M.	May 1, 1889 June 1, 1909

		Date of Membership.
Corner, Charles. Res. Engr., Rhodesia Rys. (Northern Extensions), Box 422, Bulawayo, Rhodesia, South Africa	Assoc. M. M.	May 1, 1895 Mar. 5, 1907
Coroalles, Manuel Alberto. 91 Cuba St., Havana, Cuba		Aug. 31, 1909
Corry, Thomas Avery. Res. Engr., Ferrocarriles del Sur del Peru, Arequipa, Peru		May 6, 1903
Corthell, Arthur Bateman. Secy. and Cons. Engr., Auxiliary Facilities Comm., Grand Central Terminal, 52 East 44th St., New York City		Mar. 1, 1899
Corthell, Elmer Lawrence. Caixa 58, Rio Grande, Rio Grande do Sul, Brazil		Sept. 2, 1874
Cory, Harry Thomas. Gen. Mgr., The California Development Co., Calexico, Cal	Jun. Assoc. M. M.	June 20, 1893 Mar. 7, 1900 Feb. 5, 1907
Cosby, Spencer. Col., Corps of Engrs., U. S. A., 1729 New York Ave., Washington, D. C		Oct. 5, 1904
Cotton, Joseph P. Newport, R. I		June 7, 1876
Couchot, Maurice Charles. 623 Wells Fargo Bldg., San Francisco, Cal	Assoc. M. M.	Nov. 1, 1905 June 2, 1908
Courtenay, William Howard. Chf. Engr., L. & N. R. R. Co., Louisville, Ky		July 3, 1889
Coutlee, Charles Robert Foran. Upper Ottawa Storage, Box 560, Ottawa, Ont., Canada		Mar. 1, 1905
Cowan, Herbert Wheeler. Chf. Engr., The Colorado & Southern Ry. Co., 801 Cooper Bldg., Denver, Colo		June 3, 1908
Cowles, Walter Linsley. Cons. Engr.; Secy., D. F. Holman Ry. Tracklayer Co., 1534 Masonic Temple, Chicago, Ill.		Mar. 6, 1889
N. **Cox, Leonard Martin.** Civ. Engr., U. S. N.; Asst. to the Bureau of Yards and Docks, Washington, D. C	Assoc. M. M.	Oct. 4, 1899 Jan. 5, 1904
Crandall, Charles Lee. Prof. of Ry. Eng., Cornell Univ., Ithaca, N. Y	Jun. M.	June 7, 1876 Oct. 5, 1892
Crandall, Charles Leo. Sandwich, Mass		May 4, 1909
Crane, Albert Sears. Chf. Hydr. Engr., J. G. White & Co., 49 Exchange Pl., New York City	Jun. Assoc. M M.	Sept. 3, 1895 May 4, 1898 May 1, 1901
Crane, Clarence Austin. Cons. Engr., 21 Park Row, New York City	Assoc. M. M.	Mar. 5, 1902 May 4, 1909
Crane, Francis Elihu. City Engr., Amsterdam, N. Y		Oct. 1, 1902
Craven, Alfred. Deputy Engr., Subway Constr., Public Service Comm., 1st Dist., 154 Nassau St., New York City		Dec. 5, 1888
Crawford, Joseph Emmanuel. Bridge Engr., Norfolk & West. Ry., Roanoke, Va	Jun. M.	Dec. 5, 1899 June 3, 1908
Crawford, William. Address unknown		Nov. 7, 1888
Crecelius, Samuel Forder. U. S. Engr. Office, Louisville, Ky.		Dec. 4, 1907

Member	Grade	Date of Membership.
Crehore, William Williams. Cons. Engr., 116 Nassau St., New York City	Assoc. M. M.	April 4, 1894 Sept. 3, 1902
Crellin, Edward Webster. Pres., Des Moines Bridge & Iron Works, Park Bldg., Pittsburg, Pa		Mar. 2, 1909
Cresson, Benjamin Franklin, Jr. Deputy Commr., Dept. of Docks and Ferries, Pier A, North River (Res., 32 West 40th St.), New York City	Assoc. M. M.	April 2, 1902 Jan. 7, 1908
Creuzbaur, Robert Walter. Cons. Engr. of Public Works, Office of the Pres., Borough of Brooklyn, Brooklyn, N. Y	Jun. Assoc. M. M.	April 2, 1890 April 4, 1894 April 4, 1900
Crew, Charles Corwin. Engr., A. Wyckoff & Son Co., Southern Plant, Alexandria, La	Assoc. M. M.	April 1, 1903 June 1, 1909
Crider, James Leland. Chf. Engr., N. Y., Westchester & Boston Ry., 65 Beaver St., New York City		Jan. 3, 1906
Crocker, Herbert Samuel. (Crocker & Ketchum, Cons. Engrs.), 811 Seventeenth St., Suite 438, Denver, Colo		Oct. 2, 1901
Crosby, Benjamin Lincoln. Div. Engr., N. P. Ry. Co., Tacoma, Wash	Jun. M.	June 2, 1880 Oct. 6, 1886
Crosby, Horace. 280 Main St., New Rochelle, N. Y		Feb. 17, 1869
Crosby, Walter Wilson. Chf. Engr., Md. Geologic & Economic Survey; Chf. Engr., Md. Roads Comm., Baltimore, Md		July 10, 1907
Croswell, Thomas Henry. Chf. Engr., Spokane, Portland & Seattle Ry. and Astoria & Columbia River Ry., Cor., Eleventh and Hoyt Sts., Portland, Ore		Oct. 7, 1908
Crowell, Foster. Cons. Civ. Engr., 18 Broadway, New York City		Dec. 1, 1880
Crozier, William. Brig-Gen., Chf. of Ordinance, U. S. A., War Dept., Washington, D. C		Feb. 1, 1905
Crump, Ralph Lee. 1309 Walnut St., Room 24, Philadelphia, Pa		Dec. 3, 1902
Cullen, James Francis. Asst. Engr. of Constr., P. R. R., 510 South 48th St., Philadelphia, Pa		May 2, 1906
Cummings, Robert Augustus. Pittsburg, Pa	Jun. Assoc. M. M.	Oct. 1, 1890 May 4, 1892 June 1, 1898
Cummings, William Warren. Boston Consolidated Gas Co., 24 West St., Boston, Mass		June 7, 1899
Cunningham, Andrew Chase. Insp. of Public Works, Navy Dept., Washington, D. C	Assoc. M. M.	Sept. 2, 1891 Oct. 3, 1894
Cunningham, Andrew Oswald. Chf. Engr., Wabash R. R. Co., Lincoln Trust Bldg., St. Louis, Mo		Feb. 5, 1902
Cunningham, David West. 627 West 18th St., Los Angeles, Cal		May 7, 1873
Cunningham, James Henry. 2 Ravelston Pl., Edinburgh, Scotland		Aug. 6, 1879

		Date of Membership.
CUNNINGHAM, JOSEPH HOOKER. Cons. Hydr. Engr., Sherlock Bldg., Portland, Ore	Assoc. M. M.	Sept. 6, 1899 Feb. 2, 1904
CURTIS, CHARLES ELBERT. Civ. Engr., Cambria Steel Co., Capital Hotel, Johnstown, Pa		Oct. 4, 1905
CURTIS, FAYETTE SAMUEL. Second Vice-Pres., N. Y., N. H. & H. R. R. Co., South Terminal Station, Boston, Mass		April 3, 1889
CURTIS, WALTER WHALEY. Cons. Engr., 355 Dearborn St., Chicago, Ill		Sept. 5, 1888
CUSHING, EDWARD BENJAMIN. 205½ San Jacinto St., Houston, Tex		Nov. 1, 1893
CUSHING, WILLIAM CHANNING. Chf. Engr., M. of W., South-West System, Penn. Lines., Union Station, Pittsburg, Pa	Jun. Assoc. M. M.	June 5, 1889 Nov. 4, 1891 May 1, 1901
CUSHMAN, WILLIAM HERBERT. Hydr. Engr., San José, Costa Rica		Jan. 3, 1906
DABNEY, AUGUSTINE LEE. Asst. Chf. Engr., Tallahatchie Drainage Dist., Clarksdale, Miss		Oct. 2, 1901
DABNEY, THOMAS GREGORY. Chf. Engr., Yazoo-Mississippi Delta Levee Dist., Clarksdale, Miss		Jan. 3, 1906
DAGGETT, HERBERT CHAPIN. New England Mgr. and Engr., S. Morgan Smith Co., 176 Federal St., Boston, Mass		July 10, 1907
DAHM, SVERRE. Gen. Insp. of Designs, Public Service Comm. for the First Dist., 154 Nassau St., New York City		Feb. 7, 1906
DAKIN, ALBERT HARLOW, JR. 370 St. Nicholas Ave., New York City		April 1, 1903
DALLIS, PARK ANDREW. Mill Archt. and Engr., 1023 Candler Bldg., Atlanta, Ga	Assoc. M. M.	June 1, 1904 Jan. 4, 1910
DALTON, B. J. Assoc. Prof., Railway Eng., Univ. of Kansas, 1011 Indiana St., Lawrence, Kans		Oct. 2, 1907
DANA, RICHARD TURNER. Civ. and Cons. Engr., 15 William St., New York City	Jun. Assoc. M. M.	Sept. 11, 1900 Feb. 4, 1903 Jan. 7, 1908
DANFORTH, FREDERIC. 29 Pleasant St., Gardiner, Me		Sept. 2, 1891
DANFORTH, RICHARD EUGENE. 7 Central Ave., Newark, N. J.		Oct. 3, 1906
DARLING, FRED STEERE. Div. Engr. of Constr., C. P. Ry., 112 King St., West, Toronto, Ont., Canada		Oct. 7, 1903
DARLING, JOHN HENRY. U. S. Prin. Asst. Engr., 532 West Third St., Duluth, Minn		May 1, 1901
DARLING, WILLIAM LAFAYETTE. Chf. Engr., N. P. Ry. Co., St. Paul, Minn		Oct. 5, 1892
DARRACH, CHARLES GOBRECHT. Pres. and Chf. Engr., Mt. Vernon Impvt. Co., Mt. Vernon, Skagit Co., Wash		Jan. 5, 1876
DARROW, FRANK TENNEY. Engr., M. of W., C., B. & Q., Lincoln, Nebr	Assoc. M. M.	May 1, 1907 May 4, 1909

		Date of Membership.
Dart, Carlton Rollin. Bridge Engr., San. Dist. of Chicago, 1500 Am. Trust Bldg., Chicago, Ill		May 6, 1903
Dart, Justus Vinton. Asst. Engr. in Chg. of Highway Dept., City Hall, Providence, R. I		April 4, 1900
Datesman, George Elvin. Prin. Asst. Engr., Bureau of Surveys, 416 City Hall, Philadelphia, Pa		Feb. 4, 1903
Dauchy, Walter Edward. 730 East 14th St., Davenport, Iowa.		Nov. 4, 1903
Davenport, James Aubrey. Engr. in Chg., Double Track, Welch, W. Va. (Res., 402 Fourteenth Ave., S. W., Roanoke, Va.)		April 5, 1905
Davidson, Frank Eugene. Archt. and Cons. Engr. (Patterson and Davidson), 1448 Monadnock Blk. (Res., 7436 Kimbark Ave.), Chicago, Ill		Nov. 4, 1908
Davies, John Vipond. (Jacobs & Davies, Cons. Engrs.), 30 Church St., New York City		June 6, 1894
Davis, Arthur Lincoln. Asst. to Pres., Am. Bridge Co. of N. Y., 30 Church St., New York City	Jun. Assoc. M. M.	April 4, 1893 Oct. 7, 1896 Mar. 6, 1906
Davis, Arthur Powell. Chf. Engr., U. S. Reclamation Service, Washington, D. C	Assoc. M. M.	June 7, 1893 Oct. 4, 1899
Davis, Carleton Emerson. Dept. Engr., Board of Water Supply, City of New York, Brown Station, N. Y	Assoc. M. M.	April 6, 1898 Mar. 3, 1908
Davis, Chandler. 11 Broadway, New York City.	Jun. Assoc. M. M.	Dec. 3, 1890 Feb. 6, 1895 Oct. 4, 1899
Davis, Charles E. L. B. Brig-Gen., U. S. A. (*Retired*), The Benedict, Washington, D. C		July 12, 1877
Davis, Charles Henry. South Yarmouth, Mass		Dec. 4, 1895
Davis, Charles Stratton. Vice-Pres. and Gen. Mgr., The Massillon Bridge & Structural Co., 1128 Ohio Bldg., Toledo, Ohio		Feb. 1, 1905
Davis, Chester Birge. 3353 Sixth Ave., Troy, N. Y		Feb. 1, 1882
Davis, John Rose Wilson. Engr., M. of W., G. N. Ry. Line, St. Paul, Minn		Nov. 4, 1903
Davis, Joseph Baker. Prof., Geodesy and Surveying, Univ. of Michigan, Ann Arbor, Mich	Jun. M.	April 1, 1874 Oct. 5, 1898
Davis, Joseph Phineas. 332 Palisade Ave., Yonkers, N. Y		Jan. 29, 1868
Davis, Leonard Henry. Chf. Engr., The Michigan Lake Superior Power Co., The Lake Superior Power Co., Sault Ste. Marie, Ont., Canada	Assoc. M. M.	Nov. 5, 1902 May 4, 1909
Davis, Lynn LeRoy. U. S. Asst. Engr., 22 Ketchum Pl., Buffalo, N. Y		Nov. 30, 1909
Davis, Noah Wilson. Harrisonburg, Va		July 9, 1906
Davis, Robert Benjamin. Designing Engr., Bost. Elev. Ry. Co., 101 Milk St., Boston, Mass		July 3, 1889

		Date of Membership.
Davison, George Stewart. Asst. to the Pres., Gulf Refining Co., Frick Annex, Pittsburg, Pa		April 2, 1890
Dawley, Edwin Peleg. Cons. Engr., Banigan Bldg., Providence, R. I		April 1, 1885
Dawley, William Sanborn. Chf. Engr., Yunnan-Szechuan & Tengyueh Ry. Co., Yunnanfu, Yunnan Prov., China		Oct. 4, 1905
Dawson, Edwin Ford. Asst. to Chf. Engr., P. & R. Ry., Room 516, Reading Terminal, Philadelphia, Pa		Mar. 4, 1908
Dean, Arthur Warren. Chf. Engr., Mass. Highway Comm., 15 Ashburton Pl., Boston, Mass		May 4, 1904
Dean, Bertram Dodd. Chf. Engr., Puget Sound Bridge & Dredging Co., 2322 Thirty-second Ave., South, Seattle, Wash		Aug. 31, 1909
Dean, Luther. Taunton, Mass		May 4, 1898
Deans, John Sterling. Chf. Engr., The Phœnix Bridge Co., Phœnixville, Pa		May 4, 1887
Deen, James Work. Div. Engr., D. & R. G. R. R., Salida, Colo.		Jan. 6, 1892
Defrees, Morris M. 400 Saks Bldg., Indianapolis, Ind		Mar. 3, 1880
de la Barre, William. Engr., Agt. and Treas., St. Anthony Falls Water Power Co., Minneapolis, Minn		April 5, 1893
Delano, Frederic Adrian. Pres., Wabash R. R. and Wheeling & Lake Erie R. R., Chicago, Ill		June 4, 1902
Dencer, Frederick William. Engr., Lassig Plant, Am. Bridge Co., Wrightwood and Clybourn Aves., Chicago, Ill	Assoc. M. M.	Feb. 7, 1906 Nov. 8, 1909
Dennis, Arthur Crisfield. Care, Canadian Pacific Ry. Co., Montreal, Que., Canada		Dec. 4, 1901
R. Dennis, William Franklin. Cons. Engr.; Pres., Rinehart & Dennis Co., Gen. Ry. Contrs., Colorado Bldg., Washington, D. C		Feb. 1, 1888
Derby, George McClellan. Lt.-Col., U. S. A. (*Retired*), 1015 Carrollton Ave., New Orleans, La		April 1, 1896
Derleth, Charles, Jr. Prof., Civ. Eng., Civ. Eng. Bldg., Univ. of California, Berkeley, Cal	Jun. Assoc. M. M.	Feb. 1, 1898 Mar. 5, 1902 May 5, 1908
Derrick, Henry Clay. Houston, Halifax Co., Va		Oct. 5, 1887
de Varona, Ignacio Marea. Chf. Engr., Dept. of Water Supply, Gas and Electricity, 13 Park Row Bldg., New York City		April 7, 1886
Develin, Richard Griffith. Asst. Engr., M. W., Bridges and Bldgs., P. R. R. Co., Broad St. Station, Philadelphia, Pa		May 1, 1907
Devin, George. 545 West 144th St., New York City		Sept. 7, 1887
De Witt, Philip Hoffecker. Contr. and Engr., S. B. Mutchler & Co., Phillipsburg, N. J		May 5, 1897
Deyo, Solomon LeFevre. Chf. Engr., Interborough Met. Co., 2108 Fifth Ave., New York City		June 6, 1888

		Date of Membership.
De Young, Isaac. U. S. Junior Engr., Sault Ste. Marie, Mich	Assoc. M. M.	Dec. 5, 1906 Jan. 4, 1910
Didier, Paul. Dist. Engr., B. & O. R. R. Co., Pittsburg, North Side, Pa		Mar. 6, 1889
Diebitsch, Emil. Vice-Pres., The John Peirce Co., 277 Broadway, New York City (Res., 38 Burnett Pl., Nutley, N. J.)	Jun. Assoc. M. M.	Feb. 28, 1893 Oct. 6, 1897 Mar. 5, 1902
Diehr, Alvah Benjamin. U. S. Junior Engr., Box 1017, Memphis, Tenn	Assoc. M. M.	Nov. 5, 1902 July 1, 1909
Dillenbeck, Clark. Civ. Engr. and Archt.; Asst. Engr., P. & R. Ry. Co., 502 Reading Terminal, Philadelphia, Pa		June 1, 1904
Dillman, George Lincoln. Union Trust Bldg., San Francisco, Cal		Mar. 4, 1891
Dimon, Daniel Young. With Eastern Steel Co., 71 Broadway, New York City (Res., 315 Paulison Ave., Passaic, N. J.)	Assoc. M. M.	Oct. 2, 1901 Mar. 31, 1908
Dixon, Charles Young. U. S. Asst. Engr., River and Harbor Impvts., Amherstburg, Ont., Canada		Nov. 4, 1903
Doane, Walter A. Meadville, Pa		Sept. 7, 1881
Doble, William Ashton. Fremont and Howard Sts., San Francisco, Cal		April 5, 1905
Dobson, Adna. City Engr., Lincoln, Nebr		May 6, 1908
Dockweiler, John Henry. Cons. Engr., 417 Grant Bldg., San Francisco, Cal		May 2, 1906
Dodge, James Lynn. Engr. in Chg., Frederick Office, Westinghouse, Church, Kerr & Co., Frederick, Md		July 1, 1908
Doerfling, Richard George. Civ. and Cons. Engr., 1002 Call Bldg., San Francisco, Cal.	Assoc. M. M.	June 3, 1903 Mar. 5, 1907
Domenech, Manuel Victor. P. O. Box 220, Ponce, Porto Rico		July 9, 1906
Donham, Benjamin Curtis. With J. G. White & Co., Inc., Constr. Dept., 43 Exchange Pl., New York City (Res., 24 N. 16th St., East Orange, N. J.)	Assoc. M. M.	Jan. 2, 1901 Mar. 31, 1908
Donovan, Cornelius. Prin. Asst. Engr., U. S. Engr. Office, Custom House, New Orleans, La		Oct. 4, 1899
Donovan, John Joseph. Vice-Pres. and Mgr., Lake Whatcom Logging Co.; Vice-Pres., First National Bank, and Blue Canyon Coal Min. Co., Bellingham, Wash	Jun. M.	April 7, 1886 April 4, 1888
Doremus, Abraham Fairbanks. Cons. Engr., Salt Lake City, Utah		Oct. 4, 1893
Dorr, Edgar Sutton. Chf. Engr., Sewer Div., Street Dept., 30 Tremont St., Boston, Mass		April 3, 1895
Dose, Henry Frederick. Care, Madeira-Mamoré Ry., Caixa 304, Manãos, Brazil		Jan. 6, 1904

		Date of Membership.
dos Santos, José Americo. Cons. Civ. Engr., Caixa 748, Rio de Janeiro, Brazil		Oct. 7, 1908
Dougan, William Thomas. Engr., M. of W., Met. St. Ry. Co., 775 Seventh Ave., New York City		Oct. 2, 1907
Douglas, Benjamin. Tunnel Engr., Detroit River Tunnel Co., Detroit, Mich	Jun. M.	June 1, 1887 Jan. 2, 1890
Douglas, Edward Morehouse. Geographer, U. S. Geological Survey, Washington, D. C		Dec. 4, 1901
Douglas, Walter Jules. District Bldg., Washington, D. C.		April 3, 1907
Dow, Alex. Vice-Pres. and Gen. Mgr., The Edison Illuminating Co., 18 Washington Ave., Detroit, Mich		Dec. 5, 1906
Downey, Archibald Stewart. Cons. and Const. Engr., 610 Bailey Bldg., Seattle, Wash		Nov. 30, 1909
Drake, Albert Bailey. 164 William St., New Bedford, Mass.		Oct. 4, 1893
Drake, William Abial. Vice-Pres. and Gen. Mgr., S. F., P. & P. Ry. Co. and Leased Lines, Prescott, Ariz		Dec. 5, 1883
Drury, Edmund Hazen. Sherbrooke, Que., Canada		Oct. 4, 1905
Du Bois, Augustus Jay. Prof. of Civ. Eng., Sheffield Scientific School, New Haven, Conn	Jun. M.	July 7, 1875 Oct. 5, 1892
Duffies, Edward John. U. S. Asst. Engr. and Supt., Harbor of Refuge, Harbor Beach, Mich		Jan. 3, 1906
Duggan, George Herrick. Dominion Bridge Co., Ltd., Glace Bay, N. S., Canada		Oct. 2, 1895
Duncan, Lindsay. Mech. Engr., Steptoe Val. Smelting & Min. Co., McGill, Nev	Assoc. M. M.	Feb. 3, 1904 Nov. 2, 1908
Duncklee, John Butler. Cons. Engr., 35 Fairview Ave., South Orange, N. J		April 2, 1873
Dunham, Herbert Franklin. 220 Broadway, New York City		Oct. 1, 1890
Dunham, Lewis Augustus. 42 Broadway, New York City		June 3, 1903
Dunham, William Robert, Jr. Asst. Engr., The Connecticut Co., 21 Ford Bldg., New Haven, Conn		July 9, 1906
Dunlap, De Clermont. Cons. Engr., 535 Marquette Bldg., Chicago, Ill		Jan. 4, 1888
Dunlap, Frederic Clark. Chf. Engr., Bureau of Water, 790 City Hall, Philadelphia, Pa		June 1, 1904
Dunn, Daniel Burke. Chf. Engr., Macon, Dublin & Savannah R. R., Macon, Ga		Dec. 2, 1891
Durham, Henry Welles. Res. Engr., Cape Cod Constr. Co., Sandwich, Mass		Oct. 5, 1909
Duryea, Edwin, Jr. (Duryea, Haehl & Gilman, Civ. and Min. Engrs.), 1314 Humboldt Bank Bldg., San Francisco, Cal	Jun. Assoc. M. M.	Feb. 2, 1887 Sept. 4, 1895 Feb. 2, 1898
Dyer, Arthur James. Pres. and Chf. Engr., Nashville Bridge Co., Nashville, Tenn	Assoc. M. M.	Mar. 6, 1901 Feb. 4, 1903

		Date of Membership.
Earl, George Goodell. Gen. Supt., Sewerage and Water Board, City Hall Annex, New Orleans, La	Jun. Assoc. M. M.	May 7, 1890 Dec. 2, 1891 April 4, 1894
Earle, Thomas. Supt., Bridge and Constr. Dept., Pennsylvania Steel Co., Steelton, Pa		Mar. 6, 1907
Easby, Marmaduke Ward. Cons. and Const. Engr., 1420 Chestnut St., Philadelphia, Pa	Assoc. M. M.	Nov. 4, 1891 Dec. 1, 1897
Easby, William, Jr. Prof. of Municipal Eng., Univ. of Pennsylvania, Philadelphia, Pa		Jan. 4, 1905
Easterbrook, Frederick James. 82 York Sq., New Haven, Conn		May 3, 1905
Eastwood, John Thompson. Prin. Asst. Engr., Sewerage and Water, Sewerage and Water Board, New Orleans, La	Jun. Assoc. M. M.	Mar. 6, 1894 Feb. 1, 1899 Sept. 6, 1904
Eaton, Frederick. 838 Fourth St., Santa Monica, Cal		May 5, 1886
Eavenson, Howard Nicholas. Chf. Engr., United States Coal & Coke Co., Gary, McDowell Co., W. Va	Assoc. M. M.	Mar. 6, 1901 May 1, 1906
Eckart, William Roberts. Cons. Engr., 3014 Clay St., San Francisco, Cal		Jan. 5, 1881
Eckersley, Joseph Oscar. 4269 White Plains Ave., New York City		Aug. 31, 1909
Eddy, Harrison Prescott. (Metcalf & Eddy, Cons. Engrs.), 14 Beacon St., Boston, Mass	Assoc. M. M.	May 7, 1902 Jan. 3, 1907
Edes, William Cushing. Chf. Engr., Northwestern Pac. R. R. Co., Flood Bldg., San Francisco, Cal	Jun. M.	Sept. 1, 1886 Nov. 4, 1896
Edwards, Harry Winter. Civ. and Cons. Engr., 50 Church St., New York City		June 4, 1890
Edwards, James Harvey. Asst. Chf. Engr., Am. Bridge Co., N. Y., 103 Lafayette Ave., Passaic, N. J	Jun. Assoc. M. M.	May 31, 1892 May 2, 1894 May 4, 1898
Ehle, Boyd. Constr. Supt., J. G. White & Co., Scottsbluff, Nebr	Assoc. M. M.	Jan. 3, 1894 Feb. 1, 1910
Eidlitz, Otto Marc. Engr. and Builder, 489 Fifth Ave., New York City		Sept. 2, 1902
Eldridge, Chauncey. 53 State St., Boston, Mass		May 2, 1906
Eldridge, Griffith Morgan. Mgr., Eldridge Drug Stores, Americus, Ga	Assoc. M. M.	June 1, 1892 Sept. 3, 1902
Ellery, Nathaniel. State Engr., Sacramento, Cal		Nov. 8, 1909
Elliott, Charles Gleason. Chf. of Drainage Investigations, U. S. Dept. of Agriculture, Washington, D. C		Sept. 3, 1890
Elliott, James Rutherford. Cons. Engr., Arlington Sta., Riverside, Cal	Assoc. M. M.	Sept. 4, 1901 April 5, 1904
Ellis, George Ezra. Vice-Pres., Hayes Track Appliance Co., Geneva, N. Y	Jun. Assoc. M. M.	Mar. 2, 1897 Mar. 7, 1900 Dec. 4, 1901

		Date of Membership.
Ellis, John Waldo. Cons. Engr., Woonsocket, R. I.		July 3, 1895
Ellis, Samuel Clarence. P. O. Box 1439, Boston, Mass.		Aug. 7, 1872
Ellsworth, Emory Alexander. Civ. and Hydr. Engr., 18 Dwight St., Holyoke, Mass.		June 1, 1904
Elmer, Howard Nixon. Mgr., Chicago Office, The Trenton Iron Co., 1122 Monadnock Blk., Chicago, Ill.		April 7, 1886
Elwell, Charles Clement. Engr., The Connecticut Co., Cor. State and Chapel Sts., New Haven, Conn.		July 1, 1891
Ely, Theodore Newel. Chf. of Motive Power, P. R. R., Broad St. Station, Philadelphia, Pa.		Mar. 2, 1881
Emerson, Guy Carleton. Supt. of Streets, 47 City Hall, Boston, Mass.		May 4, 1904
Emery, James Albert. Cons. Engr. with Ford, Bacon & Davis, 115 Broadway, New York City		June 4, 1902
Emig, John Witmer. Western Representative for E. C. & R. M. Shankland, 720 E. & C. Bldg., Denver, Colo.		Oct. 5, 1909
Emmons, Charles Morton. Bridge and Structural Engr., Penn Bridge Co., Beaver Falls, Pa.		April 1, 1903
Endemann, Herman Karl. Asst. Engr. in Chg., Topographical Bureau, Borough of Queens, 252 Jackson Ave., Long Island City, N. Y.	Assoc. M. M.	Mar. 6, 1901 Jan. 5, 1909
Endicott, Mordecai Thomas. Civ. Engr., U. S. N.; Rear-Admiral (*Retired*), 1330 R St., N. W., Washington, D. C.		April 4, 1877
Endo, Tokichi. Engr., Constr. Dept., The Bureau of Railways of H. I. J. M.'s Resident General, Chemulpo, Corea		Feb. 1, 1905
Eno, Frank Harvey. Prof. of Municipal Eng., Ohio State Univ., Columbus, Ohio		Mar. 4, 1903
Ericson, John Ernst. City Engr. of Chicago, 1934 Kenmore Ave., Chicago, Ill.		May 7, 1902
Erlandsen, Oscar. Pres., Metropolis Eng. Co., 359 Fulton St., Jamaica, N. Y.	Jun. Assoc. M. M.	May 1, 1889 Dec. 2, 1891 Oct. 7, 1896
Ernst, Oswald Herbert. Brig.-Gen., U. S. A. (*Retired*); Chairman, Am. Section International Waterways Comm., Westory Bldg., Washington, D. C.		July 4, 1888
Esselstyn, Horace Hovey. 274 Vinewood Ave., Detroit, Mich.		June 3, 1908
Evans, Edwin George. Hampton, N. B., Canada		July 10, 1907
Evans, Louis Hyde. Cons. Engr., Exchange Bldg., Union Stock Yards, Chicago, Ill.		July 3, 1889
Evans, Richard. 358 Fulton St., Jamaica, N. Y.		June 7, 1893
Evans, Robert Rogers. 24 Arlington St., Haverhill, Mass.		July 1, 1909
Ewen, John Meiggs. Cons. Engr., 740 Rookery Bldg., Chicago, Ill.		June 3, 1903
Ewing, William Bion. Cons. Municipal Engr., 4136 Ellis Ave., Chicago, Ill.	Jun. Assoc. M. M.	April 3, 1889 Feb. 3, 1892 Nov. 2, 1898

		Date of Membership.
Ewing, William Wallace. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City (Res., 426 Lenox Ave., Westfield, N. J.)		Oct. 7, 1908
Fairchild, Samuel Edwards, Jr. Civ. and Min. Engr., 306 Franklin Bldg., Philadelphia, Pa	Assoc. M. M.	Dec. 7, 1904 Oct. 6, 1908
Fairleigh, James Andrew. Secy. and Treas., Cushman-Fairleigh Eng. Co., 724 James Bldg., Chattanooga, Tenn.		Sept. 2, 1891
Falk, Myron Samuel. Cons. Engr., 30 Church St. (Res., 44 West 53d St.), New York City.	Jun. Assoc. M. M.	Feb. 4, 1902 Oct. 4, 1905 April 6, 1909
FANNING, JOHN THOMAS. (*Vice-President*). Cons. Engr., 330 Hennepin Ave., Minneapolis, Minn		Aug. 7, 1872
Fargo, William Gilbert. Civ. and Hydr. Engr., 303 Commonwealth Bldg., Jackson, Mich		April 1, 1908
Farley, Godfrey Pearson. Civ. and Cons. Engr., 58 West 59th St., New York City		June 6, 1900
Farley, John Moyer. Cons. Engr., 1 Madison Ave., New York City	Jun. Assoc. M. M.	Dec. 5, 1888 July 1, 1891 Sept. 1, 1897
Farley, Philip Patrick. Pres., Jamaica Bay Impvt. Comm., 180 Montague St. (Res., 194 McDonough St.), Brooklyn, N. Y.	Jun. Assoc. M. M.	Oct. 31, 1893 Mar. 6, 1901 Feb. 1, 1910
Farnum, Henry Harrison. 150 East 150th St., New York City		July 1, 1891
Farnum, Loring Nelson. Vice-Pres., J. G. White & Co., Inc., 43 Exchange Pl., New York City		Dec. 4, 1907
Farrar, Hartwell Prentice. Cons. Engr., Jackson, Tenn.		Nov. 1, 1893
Farrington, Harvey. Cons. and Contr. Engr., 45 Broadway, New York City	Jun. Assoc. M. M.	June 19, 1891 Feb. 6, 1895 Oct. 1, 1902
Fauntleroy, James Dearing. Care, U. S. Reclamation Service, Yuma, Ariz		June 5, 1907
Fay, Edward Bayrd. (Brenneke & Fay, Cons. Engrs.), 1009 Fullerton Bldg., St. Louis, Mo	Assoc. M. M.	Jan. 8, 1902 Jan. 2, 1906
Fay, Frederic Harold. Asst. Engr., Eng. Dept., 60 City Hall, Boston, Mass	Jun. Assoc. M. M.	Oct. 2, 1894 April 2, 1902 Jan. 5, 1904
Fehr, Harrison Robert. Pres. and Gen. Mgr., Easton Transit Co., Easton, Pa		Oct. 5, 1898
Felt, Charles Frederick Wilson. Chf. Engr., A., T. & S. F. Ry., Topeka, Kans		Mar. 3, 1897
Feltham, Percy Marshall. Greenville, S. C.		July 1, 1908

		Date of Membership.
Felton, Burton Rogers. Treas., C. E. Trumbull Co., Engrs. and Contrs., Tremont Bldg., Boston, Mass	Assoc. M. M.	April 4, 1894 Oct. 7, 1896
Felton, Herbert Clark. Supt., Del. River Ferry Co. of N. J. of P. & R. Ry. System, Camden, N. J		June 1, 1887
Felton, Samuel Morse. Pres., Chic. Gt. West. R. R., Chicago, Ill		Jan. 4, 1882
Fendall, Benjamin Truman. City Engr., 141 W. Lanvale St., Baltimore, Md		May 7, 1902
Fenkell, George Harrison. Civ. Engr. to Water Commrs. (Res., 334 Field Ave.), Detroit, Mich	Jun. Assoc. M. M.	Jan. 3, 1899 Oct. 1, 1902 July 1, 1909
Fenn, Robert Willson. Care, Union Oil Co. of California, Security Bldg., Los Angeles, Cal	Assoc. M. M.	July 10, 1907 Sept. 1, 1908
Fenn, William Henry. Room 226, du Pont Bldg., Wilmington, Del		July 1, 1909
Ferguson, George Robert. Asst. Engr., Dept. of Bridges, 1215 Park Row Bldg., New York City		Dec. 3, 1902
Ferguson, Hardy Smith. Chf. Engr., Great Northern Paper Co., Millinocket, Me	Assoc. M. M.	Mar. 3, 1897 May 1, 1901
Ferguson, John Berton. (J. B. Ferguson & Co., Civ. and Mech. Engrs.), Hagerstown, Md		July 1, 1909
Ferguson, John Neil. Div. Engr., Charles River Basin Comm., Lock-Gate House, Cor. Charles and Leverett Sts., Boston, Mass	Assoc. M. M.	Oct. 2, 1901 May 5, 1908
Ferguson, John William. Engr. and Bldg. Contr., 152 Market St., Paterson, N. J	Jun. M.	Jan. 5, 1881 Feb. 2, 1887
Fernald, Clarence Thayer. First Asst. Engr., Elev. and Subway Constr., Bost. Elev. Ry. Co., 32 Malvern St., Melrose, Mass		Oct. 7, 1908
Fernstrom, Henning. Chf. Engr., The Virginian Ry. Co., Norfolk, Va		May 7, 1902
Ferry, Charles Addison. With A. B. Hill, Cons. Civ. Engr., 24 Edgewood Ave., New Haven, Conn	Jun. M.	May 4, 1881 Jan. 2, 1889
Fetherston, John Turney. Supt. of St. Cleaning, Borough of Richmond, New York City; Res., 102 Westervelt Ave., New Brighton, N. Y	Assoc. M. M.	June 3, 1903 Oct. 5, 1909
Fickes, Clark Robinson. Bridge Dept., C., B. & Q. R. R., 209 Adams St., Chicago, Ill		Nov. 7, 1906
Fickes, Edwin Stanton. Chf. Engr. and Purchasing Agt., Aluminum Co. of America, Pittsburg, Pa	Jun. Assoc. M. M.	Jan. 4, 1898 Feb. 6, 1901 Dec. 6, 1904
Fiebeger, Gustave Joseph. Lt.-Col., Corps of Engrs., U. S. A.; Prof. of Eng., West Point, N. Y		Oct. 2, 1895

		Date of Membership.
FIELD, GEORGE RUSSELL. Asst. Gen. Mgr., Great Western Power Co., Shreve Bldg., San Francisco, Cal		Nov. 6, 1907
FIELD, GEORGE SPENCER. 452 Delaware Ave., Buffalo, N. Y.		April 7, 1880
FIELD, JOHN ELLIS. 435 Century Bldg., Denver, Colo		July 1, 1908
FIELD, WILLIAM PIERSON. 976 Broad St., Newark, N. J.	Jun. M.	Dec. 7, 1887 Mar. 6, 1901
FIELDS, SAMUEL JAMES. 632 Ellicott St., Buffalo, N. Y.		Mar. 5, 1884
FINK, RUDOLPH. St. Matthews, Ky		Sept. 21, 1870
FINLEY, EDWIN CLIFFORD. Pres. and Engr., Itawamba Eng. Co., 308 South 8th St., St. Louis, Mo	Assoc. M. M.	April 5, 1905 Nov. 30, 1909
FINLEY, WILLIAM HENRY. Asst. Chf. Engr., C. & N. W. Ry., Batavia, Ill		Feb. 4, 1903
FIRMSTONE, FRANK. Easton, Pa		Aug. 7, 1878
FISH, JOHN CHARLES LOUNSBURY. Box 233, Stanford University, Cal	Jun. Assoc. M. M.	Jan. 31, 1893 Feb. 7, 1900 Oct. 6, 1908
FISHER, EDWIN AUGUSTUS. City Engr., 294 Troup St., Rochester, N. Y		July 4, 1888
FISHER, FRANCIS DAVIS. Engr. in Chg., Degnon Cape Cod Canal Constr. Co., Sandwich, Mass		May 2, 1888
FISHER, JANON. 613 American Bldg., Baltimore, Md	Assoc. M. M.	May 4, 1892 Jan. 5, 1898
FISHER, SAMUEL BROWNLEE. Chf. Engr., Mo., Kans. & Tex. Ry. Co., 407 Wainwright Bldg., St. Louis, Mo		Oct. 7, 1903
FISK, WALTER LESLIE. Col., Corps of Engrs., U. S. A., 540 Federal Bldg., Buffalo, N. Y		April 1, 1896
FITCH, ASA BETTS. 415 W. Prospect Ave., Hollywood Station, Los Angeles, Cal		Mar. 5, 1884
FITCH, CHARLES HALL. Mgr., Idaho Irrig. Co., Ltd., Richfield, Idaho		June 5, 1901
FITCH, CHARLES LINCOLN. 253 Throop Ave., Brooklyn, N. Y.		Oct. 2, 1901
FITCH, GRAHAM DENBY. Lt.-Col., Corps of Engrs., U. S. A., U. S. Engr. Office, Duluth, Minn		Feb. 4, 1903
FITCH, HOWARD AUGUSTUS. Pres., Kansas City Structural Steel Co., 1012 Baltimore Ave., Kansas City, Mo		July 9, 1906
N. FITZGERALD, DESMOND. (*Past-President*). Cons. Hydr. Engr., Brookline, Mass		Sept. 3, 1884
FITZGERALD, JOHN LELAND. City Engr., 175 Jay St., Schenectady, N. Y		Jan. 2, 1889
FLAD, EDWARD. Cons. Engr., 1009 Fullerton Bldg., St. Louis, Mo	Jun. M.	Jan. 7, 1885 Feb. 1, 1888
FLAGG, JOSIAH FOSTER. 2001 Anacapa St., Santa Barbara, Cal		Oct. 7, 1874
FLEMING, HARVEY BROWN. Chf. Engr., Chicago City Ry. Co., 1640 First National Bank Bldg., Chicago, Ill		Mar. 4, 1908

		Date of Membership.
Fleming, *Sir* **Sandford.** Ottawa, Ont., Canada		Sept. 18, 1872
Fletcher, Austin Bradstreet. Secy.-Engr., Highway Comm. of San Diego County, 406 Scripps Bldg., San Diego, Cal.		June 1, 1909
Fletcher, Robert. Prof. of Civ. Eng. and Director of Thayer School of Civ. Eng., Dartmouth Coll., Hanover, N. H.	Assoc. M.	Nov. 4, 1874 Aug. 31, 1909
Flinn, Alfred Douglas. Dept. Engr., Board of Water Supply, 299 Broadway, New York City (Res., Glenbrook Ave., Park Hill, Yonkers, N. Y.)	Assoc. M. M.	Dec. 6, 1899 May 2, 1905
Floesch, Jacob Martin. Contr. (Corbett, Floesch Co.), Moncton, N. B., Canada		Jan. 4, 1905
Flynn, John, Jr. Civ. and Elec. Engr.; City Engr., 83 Third St., Troy, N. Y.	Assoc. M. M.	Jan. 8, 1902 May 2, 1905
Follett, William W. U. S. Cons. Engr., International Boundary Comm., United States and Mexico, El Paso, Tex.		July 5, 1893
Folwell, Amory Prescott. Editor, *Municipal Journal and Engineer,* 239 West 39th St., New York City	Jun. Assoc. M. M.	Feb. 5, 1890 June 7, 1893 Nov. 3, 1897
FOOTE, ARTHUR DeWINT. (*Director*). Supt., North Star Mines Co., Grass Valley, Cal		May 7, 1884
Force, Cyrus Gildersleeve. Cons. Civ. Engr., Flanders, Morris Co., N. J.		Feb. 6, 1878
Ford, Frederick Luther. City Engr., Hartford, Conn.	Assoc. M. M.	Oct. 1, 1902 Oct. 31, 1905
Ford, Porter Dwight. Cons. and Constr. Engr., Park Row Bldg., New York City		Jan. 4, 1905
Ford, Theodore Boyden. 946 Main St., Bridgeport, Conn.		Dec. 6, 1905
Ford, William Griffing. Cons. Engr., 190 Montague St., Brooklyn, N. Y.		Oct. 5, 1904
Ford, William Hayden. Civ. and Cons. Engr., 1024 Arcade Bldg., Philadelphia, Pa.	Jun. Assoc. M. M.	Nov. 5, 1895 June 3, 1903 Sept. 1, 1908
Forgie, James. (Jacobs & Davies, Cons. Engrs.), 30 Church St., New York City		Oct. 5, 1904
Forsyth, Robert. Cons. Engr., 1159 The Rookery, Chicago, Ill.		May 12, 1875
Fort, Edwin John. Chf. Engr. of Sewers, 1014 Mechanics Bank Bldg., Brooklyn, N. Y.	Assoc. M. M.	April 1, 1896 Nov. 1, 1904
Fortin, Sifroy Joseph. Representing Milliken Bros., Apartado 1244, City of Mexico, Mexico	Assoc. M. M.	Nov. 6, 1895 Dec. 6, 1904
Foss, Fred Eugene. Prof., Civ. Eng., Cooper Union, New York City		April 1, 1903
Foss, William Everett. Div. Engr., Met. Water-Works, 1 Ashburton Pl., Boston, Mass.		Mar. 4, 1908

			Date of Membership.
	Foster, Ernest Howard. Vice-Pres., Power Specialty Co., 111 Broadway, New York City		May 6, 1903
	Foster, Wilbur Fisk. 1702 West End Ave., Nashville, Tenn.		May 7, 1873
	Fouquet, John Douglas. Fishkill, N. Y.		June 3, 1885
	Fowler, Charles Evan. Pres. and Chf. Engr., International Contract Co., 501 Central Bldg., Seattle, Wash.	Jun. Assoc. M. M.	May 7, 1890 Dec. 6, 1893 May 3, 1898
	Fowler, Thomas Walker. Civ., Mech. and Elec. Engr., 421 Collins St., Melbourne, Victoria, Australia		Dec. 2, 1903
	Fox, Henry. Chf. Engr., Maryland Dredging & Contr. Co. and Furst Clark Dredging Co. (Res., 2912 Evergreen Terrace), Baltimore, Md.		July 1, 1909
	Fox, John Angell. Special Director, The National Rivers and Harbors Congress of the United States, 204 E. Front St., Cincinnati, Ohio		Feb. 2, 1909
	Fox, Stephenson Waters. Cons. Engr., Kansas City Life Bldg., Kansas City, Mo.	Jun. M.	July 7, 1880 Oct. 6, 1886
	Francis, Charles. 8 Masonic Temple, Davenport, Iowa		May 4, 1892
R.	Francis, George Blinn. Cons. Civ. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	Jun. M.	Sept. 5, 1883 Nov. 7, 1888
	Francis, Henry Newton. Arlington, R. I.	Jun. M.	Mar. 1, 1876 Nov. 7, 1888
	Francis, Walter Joseph. Cons. Engr., Commercial Union Bldg., Montreal, Que., Canada	Assoc. M. M.	May 1, 1901 April 5, 1904
	Franklin, Benjamin. Civ. and Cons. Engr. (Franklin & Clarke), 906 Crozer Bldg., Philadelphia, Pa.	Assoc. M. M.	April 1, 1903 June 5, 1906
	Fraser, Charles Edward. Pres., Charles E. Fraser & Co., Marbridge Bldg., 34th St. and Broadway, New York City	Jun. Assoc. M. M.	June 4, 1901 Sept. 2, 1903 June 2, 1908
	Frazier, Harry. Cons. Engr., 812 Am. Nat. Bank Bldg., Richmond, Va.		May 1, 1889
	Frazier, James Lewis. Cons. Engr., Weissinger-Gaulbert Bldg., Louisville, Ky.		Sept. 1, 1880
	Frazier, James Welch. Cons. Engr. (Frazier & Fox), Rockefeller Bldg., Cleveland, Ohio	Assoc. M. M.	May 6, 1903 Sept. 5, 1905
	Freeland, Chester Shepard. Asst. Engr., Eng. Dept., S. P. Co., Flood Bldg., San Francisco, Cal.		Jan. 3, 1906
N. N.	Freeman, John Ripley. Consulting Hydraulic Engineer; also Pres., Manufacturers Mutual Fire Insurance Co., 815 Banigan Bldg., Providence, R. I.	Jun. M.	June 7, 1882 April 3, 1889
	French, Alexis Henry. Town Engr., Town Hall, Brookline, Mass.		June 6, 1894

		Date of Membership.
FRENCH, ARTHUR WILLARD. Prof. of Civ. Eng., Worcester Polytechnic Inst., Worcester, Mass	Assoc. M. M.	April 4, 1900 Dec. 6, 1904
FRENCH, FRANK CHAUNCEY. Cons. Engr., 13 S. & Co. Rd., Salt Lake City, Utah	Assoc. M. M.	Dec. 3, 1902 Feb. 4, 1908
FRENCH, JAMES ADAMS. Engr., U. S. Reclamation Service, Engle, N. Mex		July 1, 1909
FRENCH, JAMES BENTON. Cons. Engr., 50 Church St., Room 1276, New York City	Jun. Assoc. M. M.	Feb. 6, 1899 Feb. 7, 1894 Nov. 2, 1898
FRENCH, OWEN BERT. Asst., Coast and Geodetic Survey, Honolulu, Hawaii		April 1, 1903
FREW, ARCHIBALD SMITH. Engr. in Chg., Almaden-Etheridge Ry., Almaden, North Queensland, Australia		Oct. 3, 1900
FREYHOLD, FELIX. 236 First St., S. E., Washington, D. C	Assoc. M. M.	Sept. 2, 1891 April 2, 1902
FRINK, ELLIS ALEXANDER. Bridge Engr., S. A. L. Ry., Portsmouth, Va	Assoc. M. M.	June 6, 1900 Dec. 4, 1901
FRITCH, LOUIS CHARLTON. Chf. Engr., C. G. W. R. R., 468 Grand Central Station, Chicago, Ill		Oct. 3. 1900
FRITZ, JOHN. 155 Market St., Bethlehem, Pa	M. Hon. M.	July 5, 1893 Sept. 5, 1899
FRIZELL, JOSEPH PALMER. Civ. and Hydr. Engr., 75 Linden St., Dorchester Dist., Boston, Mass		Jan. 3, 1883
FROSELL, CARL GUSTAF. Engr., Dept. of Wharves, Docks and Ferries, City of Philadelphia, Bourse Bldg., Philadelphia, Pa		April 4, 1906
FRYE, ALBERT IRVIN. Civ. and Cons. Engr., 220 Broadway, New York City		Dec. 2, 1896
FUERTES, JAMES HILLHOUSE. Hydr. and San. Engr., 140 Nassau St., New York City	Jun. M.	May 2, 1888 Feb. 6, 1895
FULLER, FRANK LOUIS. 12 Pearl St., Room 34, Boston, Mass	Jun. M.	April 4, 1883 April 4, 1888
FULLER, FRANKLIN IDE. Vice-Pres., Portland Ry., Light & Power Co., Electric Bldg., Portland, Ore		Jan. 6, 1886
FULLER, GEORGE WARREN. (Hering & Fuller, Hydr. and San. Engrs.), 170 Broadway, New York City	Assoc. M. M.	Mar. 1, 1899 May 31, 1904
FULLER, HARRY. Chf. Engr., King Bridge Co., Cleveland, Ohio.		Sept. 7, 1904
FULLER, WILLIAM BARNARD. Cons. Civ. Engr., 150 Nassau St., New York City	Jun. M.	June 3, 1885 May 1, 1895
FULTON, JOHN ADDISON. 934 West Sixth St., Los Angeles, Cal.		May 4, 1887
FURBER, WILLIAM COPELAND. Archt. and Cons. Engr., 418 Walnut St., Philadelphia, Pa		May 2, 1899
FURMAN, JOB ROCKFIELD. Chf. Mech. Engr., D. H. Burnham & Co., Chicago, Ill	Jun. M.	July 2, 1890 Dec. 7, 1904

		Date of Membership.
Fyfe, James Lincoln. (E. C. and R. M. Shankland), 1106 Rookery, Chicago, Ill		Oct. 5, 1904
Gadsden, George Morrall. Pres. of The Gadsden Contr. Co., Savannah, Ga		May 4, 1898
Gagel, Edward. Chf. Engr., N. Y., N. H. & H. R. R. (Res., 323 Center St.), West Haven, Conn		April 3, 1907
Gahagan, Walter Hamer. Contr. Engr., 189 Montague St., Brooklyn, N. Y	Jun. Assoc. M. M.	Sept. 5, 1888 July 1, 1891 April 3, 1901
Galloway, John Debo. (Galloway & Markwart), First National Bank Bldg., San Francisco, Cal		Dec. 6, 1905
Gamble, Francis Clarke. Public Works Engr. and Insp. of Railways, British Columbia, Victoria, B. C., Canada		April 1, 1891
Gardiner, Frederick William. Prin. Asst. Engr., Interborough Rap. Trans. Co., Manhattan Ry. Div., 165 Broadway, New York City	Assoc. M. M.	Dec. 6, 1899 Nov. 2, 1908
Gardner, Edmund LeBreton. Pres., Jersey City Water Supply Co., 158 Ellison St., Paterson, N. J		June 7, 1882
Gardner, Martin Luther. Asst. Engr., P. R. R., Jersey City (Res., 66 Milford Ave., Newark), N. J	Assoc. M. M.	Sept. 2, 1891 Mar. 4, 1896
GARDNER, WILLIAM MONTGOMERY. (*Director*). P. O. Box 1027, Care U. S. Engr.'s Office, Memphis, Tenn		Dec. 7, 1904
Garlinghouse, Frederick Leman. Glenshaw, Pa		Mar. 7, 1906
Garrett, James Edwin. Asst. Mgr., Min. Dept., Cia. M., F. y A. "Monterey," S. A., Apartado No. 283, Monterey, N. L., Mexico		April 5, 1905
Garrett, Robert Peel. Secy., Missouri Bridge & Iron Co., 1000 Fullerton Bldg., St. Louis, Mo	Jun. Assoc. M. M.	Jan. 4, 1898 Oct. 2, 1901 Mar. 5, 1907
Garrison, Everett. Cons. Engr., Newburgh, N. Y		Mar. 7, 1894
Garrison, Frank Lynwood. Min. Engr., 760 Drexel Bldg., Philadelphia, Pa	Assoc. M. M.	Sept. 7, 1892 Mar. 5, 1907
Gaston, Louis Prevost. (Richards & Gaston), 143 Liberty St., New York City		Feb. 1, 1905
Gates, Christopher Lawrence. Cons. Engr., 416 Irving St., Toledo, Ohio	Jun. M.	Dec. 4, 1878 Sept. 5, 1883
Gates, Horace Delphos. Asst. in Office of City Engr., City Engr.'s Office, San Francisco, Cal		Mar. 7, 1883
Gault, Homer Johnston. Engr., U. S. Reclamation Service, Engle, N. Mex		Oct. 2, 1907
Gaut, Robert Eugene. Engr. of Bridges and Bldgs., I. C. R. R., Central Station, Room 1000, Chicago, Ill		April 3, 1907
Gay, Charles Webster. 25 Exchange St., Lynn, Mass		May 6, 1891

		Date of Membership.
Gay, Martin. Asst. Engr., Dept. of Bridges, New York City, 103 East 125th St., New York City	Jun. M.	June 4, 1884 June 5, 1889
Gayler, Carl. 900 Wainwright Bldg., St. Louis, Mo.		Sept. 3, 1884
Gayol, Roberto. Cons. Engr.; Chf. Engr. of the Sauteña Irrig. Works, P. O. Box 766, City of Mexico, Mexico		Mar. 2, 1892
Gazlay, Webster. Engr. and Vice-Pres., National Concrete Constr. Co., Board of Trade Bldg., Louisville, Ky.		June 7, 1905
Geddes, Edmond Burns. U. S. Asst. Engr., Natchez, Miss.		Mar. 2, 1898
Geddes, James Kennon. Gen. Mgr., Ohio River & Western Ry. Co., Zanesville, Ohio		Jan. 2, 1890
Geer, Harvey Mosher. Ballston, N. Y.		June 6, 1894
Gemmell, Robert Campbell. Asst. Gen. Mgr., Utah Copper Co., Ray Cons. Copper Co., Gila Copper Co. and Chino Copper Co., McCormick Bldg., Salt Lake City, Utah	Assoc. M. M.	Oct. 5, 1892 Dec. 4, 1895
Gerber, Emil. Asst. to Pres., Am. Bridge Co., Frick Bldg., Pittsburg, Pa.		Feb. 1, 1888
Gerig, William. Second Vice-Pres. and Chf. Engr., Pac. & Eastern Ry., Medford, Ore.		Mar. 5, 1902
Gerry, Martin Hughes, Jr. Chf. Engr. and Gen. Mgr., Missouri River Power Co., Helena, Mont.	Assoc. M. M.	June 6, 1900 Dec. 3, 1902
Gessner, Gustavus Adolphus, Jr. Vice-Pres. and Chf. Engr., The Am. Eng. & Constr. Co., 702 Schofield Bldg., Cleveland (Res., 2465 Scottwood Ave, Toledo), Ohio	Assoc. M. M.	April 2, 1902 Oct. 3, 1905
Getman, Frank Lawton. Cons. Engr. and Mfrs. Agt.; (T. M. Keene & Co.), 438 Lonja de Comercia, Havana, Cuba	Assoc. M. M.	April 5, 1905 May 4, 1909
Gibbs, George. Chf. Engr., Elec. Traction and Station Constr., P. T. & T. R. R. Co., 10 Bridge St., New York City		Mar. 6, 1895
Giddings, Frederick. Atchison, Kans.		June 6, 1906
Gifford, George Edwin. Vice-Pres. and Gen. Mgr., The S. W. Bowles Co., 17 West 42d St., New York City	Assoc. M. M.	Oct. 7, 1891 Jan. 1, 1896
Gifford, Robert Ladd. Pres., Illinois Eng. Co., Monadnock Blk. (Res., 4908 Kimbark Ave.), Chicago, Ill.	Assoc. M. M.	May 6, 1903 June 4, 1907
Giles, Robert. 59 West 45th St., New York City		May 6, 1891
Gilfillan, George Aiken. Cons. Civ. Engr., 341 Fourth Ave., Pittsburg, Pa.		Dec. 6, 1905
Gillespie, Richard Henwood. Cons. Engr., 2774 Briggs Ave., Bedford Park, New York City	Assoc. M. M.	Oct. 3, 1900 June 5, 1906
Gillette, Edward. Supt., Sheridan Div., C., B. & Q. Ry., Sheridan, Wyo.		July 3, 1889

			Date of Membership.
	Gillette, Halbert Powers. Editor, *Engineering-Contracting,* 355 Dearborn St., Room 904, Chicago, Ill.		May 4, 1904
	Gillette, Lewis Singer. Pres., Elec. Steel Elevator Co., Minneapolis, Minn.		June 7, 1899
	Gilman, James Beatty. Chf. Engr., Minneapolis Steel & Machinery Co., Minneapolis, Minn.		Oct. 7, 1908
	Gladding, Henry Holbrook. Asst. City Engr., 30 Stanley St., New Haven, Conn.	Jun. M.	July 1, 1885 Jan. 4, 1888
	Glasgow, Arthur Graham. (Humphreys & Glasgow), 38 Victoria St., Westminster, London, England		Jan. 3, 1900
	Glazier, William Leonard. Engr. and Supt. of Water-Works, Newport, Ky.	Assoc. M. M.	Oct. 7, 1903 Mar. 5, 1907
	Goad, Charles Edward. 15 Wellington St., West, Toronto, Ont., Canada		Sept. 7, 1881
	Goddard, Leslie Warren. U. S. Asst. Engr., U. S. Engr. Office, Grand Rapids, Mich.	Assoc. M. M.	Mar. 2, 1892 Oct. 6, 1908
	Godfrey, Edward. Structural Engr. (Robert W. Hunt & Co.), Monongahela Bank Bldg., Pittsburg, Pa.		Oct. 5, 1909
	Going, Alvah Seymour. Locating Engr., G. T. Ry. System, 407 G. T. Ry. Bldg., Montreal, Que., Canada	Assoc. M. M.	May 4, 1892 June 7, 1899
R.	**Goldmark, Henry.** Designing Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Jun. M.	May 7, 1884 June 6, 1888
	Goodale, Loomis Farrington. Superv. Railway Expert to the Govt. of the Philippine Islands, Manila, Philippine Islands		Nov. 7, 1900
	Goodnough, Xanthus Henry. Chf. Engr., State Board of Health, Room 140, State House, Boston, Mass.	Assoc. M. M.	May 6, 1896 June 4, 1902
C.	**Goodrich, Ernest Payson.** Cons. Engr., 1 Wall St., New York City	Jun. M.	April 3, 1900 Nov. 1, 1905
	Goodrich, Wilbur Francis. Cons. Engr., 10 Gibbens St., Somerville, Mass.		May 4, 1887
	Goodwin, George Estyn. Project Engr., U. S. Reclamation Service, Family, Mont.	Assoc. M. M.	Jan. 8, 1908 July 1, 1909
	Goodwin, James Bowman. Supt. of Constr., Contracts 64 and 66, New York State Barge Canal, for Empire Eng. Corporation, Medina, N. Y.		Dec. 4, 1907
	Gordon, Charles Edward. Care, Dept. of Public Works, Manila, Philippine Islands		Sept. 6, 1905
	Gotshall, William Charles. 1 West 72d St., New York City.		May 7, 1902
	Gould, Harry Madera. Vice-Pres. and Gen. Mgr., Foster-Creighton-Gould Co., Engrs. and Gen. Contrs., 3 Berry Blk., Nashville, Tenn.		Nov. 30, 1909

		Date of Membership.
GOULD, WILLIAM TILLOTSON. Asst. Engr., P. T. & T. R. R. Co., 140 Third St., Long Island City (Res., Hastings-on-Hudson), N. Y.		Jan. 2, 1890
GOVE, WILLIAM GRANVILLE. Supt. of Equipment, Brooklyn Rapid Transit System, 85 Clinton St., Brooklyn, N. Y.	Assoc. M. M.	Feb. 3, 1904 Feb. 1, 1910
GOVERN, EDWARD JAMES. Cons. and Const. Engr., 939 Granite Bldg., Rochester, N. Y.		Jan. 8, 1908
GRACE, ARTHUR. Chf. Engr., Southern Alberta Land Co., Ltd., Medicine Hat, Alta., Canada		July 1, 1909
GRADY, CHARLES BENEDICT. Asst. Mech. Engr., New York Edison Co., 55 Duane St., New York City	Assoc. M. M.	Sept. 6, 1905 Aug. 31, 1909
GRAFTON, CHARLES EDWIN. New Cumberland, W. Va.		Jan. 1, 1896
GRAHAM, CHARLES HALLETT. Engr. in Chg. of Sewers, Borough of the Bronx, 177th St. and Third Ave., New York City.		Sept. 7, 1887
GRANBERY, JULIAN HASTINGS. 20 Broad St., New York City	Jun. Assoc. M. M.	Sept. 6, 1898 Sept. 2, 1903 April 6, 1909
GRANT, EMERSON WARREN. Asst. Engr., A., T. & S. F. Ry. Co., 24th and Topeka Ave., Topeka, Kans.		Dec. 4, 1889
GRANT, JUSTUS HERBERT. Contr. Engr., 78 South Goodman St., Rochester, N. Y.		Mar. 2, 1892
GRANTHAM, HERBERT THOMAS. Chf. Engr., Belmont Iron Works, 1622 Real Estate Trust Bldg., Philadelphia, Pa.	Assoc. M. M.	Feb. 5, 1896 May 7, 1902
GRAVES, EDWIN DWIGHT. Address unknown	Assoc. M. M.	Jan. 2, 1895 Dec. 2, 1896
GRAVES, WALTER HAYDEN. Box 298, Portland, Ore.		Feb. 2, 1909
GRAVES, WALTER JOSEPH. U. S. Engr. Office, Sault Ste. Marie, Mich.	Assoc. M. M.	July 9, 1906 Jan. 4, 1910
GRAY, GEORGE EDWARD. Cons. Engr.; U. S. Naval Hospital, Care, Dr. M. H. Simons, Mare Island, Cal.	M. Hon. M.	July 2, 1873 June 5, 1894
GRAY, JOHN HENRY. Pres., J. H. Gray Co., 2019 Fuller Bldg., New York City		Oct. 2, 1895
GRAY, SAMUEL MERRILL. Cons. Engr., Providence, R. I.		May 15, 1872
GREEN, BERNARD LINCOLN. Secy., The Osborn Eng. Co., Osborn Bldg., Cleveland, Ohio		April 3, 1901
GREEN, BERNARD RICHARDSON. Supt., Building and Grounds, Library of Congress, Washington, D. C.		Oct. 2, 1889
GREEN, HUBERT EDWARD. Res. Engr., Riverside Groves and Water Co., Arlington Station, Riverside, Cal.		Dec. 2, 1903
GREEN, SAMUEL MARTIN. Cons. Engr., 318 Main St., Springfield, Mass.		July 1, 1908

		Date of Membership.
Greene, Francis Vinton. Pres., Niagara, Lockport & Ontario Power Co., Fidelity Bldg., Buffalo, N. Y		June 3, 1885
Greene, George Sears, Jr. Cons. Engr., 11 Broadway, New York City		Dec. 4, 1897
Greene, Robert Maxson. Asst. Engr., Am. Bridge Co., Ambridge, Pa	Assoc. M. M.	June 1, 1898 Sept. 1, 1908
Gregory, John Herbert. Passaic Valley Sewerage Commrs., 92 Park Pl., Newark, N. J	Jun. Assoc. M. M.	Jan. 3, 1899 April 3, 1901 Dec. 4, 1906
Gregory, Luther Elwood. Civ. Engr., U. S. N., U. S. Navy Yard, Portsmouth, N. H		April 6, 1904
Gregory, William Benjamin. Prof. of Experimental Eng., Tulane Univ.; Irrig. Engr., U. S. Dept. of Agriculture, 630 Pine St., New Orleans, La		Nov. 8, 1909
N. Greiner, John Edwin. Cons. Engr., Continental Bldg., Baltimore, Md		June 4, 1890
Gresham, Robert Hall. Chf. Engr., Asherton & Gulf Ry., 724 West Poplar St., San Antonio, Tex		May 4, 1898
Griffin, William Reid Wesley. Gen. Supt. of Transportation, Rochester Ry. Co., 267 State St., Rochester, N. Y		Feb. 5, 1908
Griggs, Julian. Chf. Engr., Scioto Val. Traction Co., Columbus, Ohio		Oct. 4, 1899
Grimes, Edwin Lincoln. City Engr., City Hall, Troy, N. Y		Mar. 2, 1904
Grimm, Carl Robert. Standish Arms, Brooklyn, N. Y		June 4, 1890
Grimshaw, James Walter. St. Stephen's Club, Westminster, London, S. W., England		Nov. 7, 1888
Grossart, Lewis John Henry. Town Engr., Northampton and Hellertown, Pa.; Address, 423 Commonwealth Bldg., Allentown, Pa		May 1, 1907
Grunsky, Carl Ewald. Cons. Civ. Engr., 45 Broadway, New York City		Oct. 5, 1898
Gumaer, Edward Bennet. Allenhurst, N. J		Sept. 6, 1905
Gunn, William Edward. Middlesboro, Ky		April 5, 1905
Gunnell, William Covington. Cosmos Club, 1520 H St., N. W., Washington, D. C		Feb. 7, 1877
Guppy, Benjamin Wilder. Bridge Engr., B. & M. R. R., North Union Station, Boston, Mass	Jun. Assoc. M. M.	June 19, 1891 Oct. 3, 1894 Feb. 6, 1901
Gutelius, Frederick Passmore. Gen. Supt., Lake Superior Div., Canadian Pacific Ry., North Bay, Ont., Canada		Oct. 3, 1906
Guthrie, Edward Buckingham. Chf. Engr., Grade Crossing Comm., 436 Ellicott Sq. (Res., 562 West Ferry St.), Buffalo, N. Y	Assoc. M.	Sept. 3, 1884 Oct. 5, 1887

		Date of Membership.
Haas, Edward Francis. Merchants Exchange Bldg., San Francisco, Cal	Jun.	Feb. 6, 1894
	Assoc. M.	Sept. 5, 1900
	M.	Feb. 6, 1906
Hackney, John Wesley. (Ashmead & Hackney), 622 Bartlett Bldg., Atlantic City, N. J		Oct. 5, 1909
Hadsall, Harry Hugh. Gen. Supt., Leonard Constr. Co., 1417 Monadnock Blk., Chicago, Ill		Mar. 6, 1907
Hague, Charles Arthur. Cons. Engr., 52 Broadway, New York City		Feb. 3, 1892
Haight, Stephen Samuel. Civ. Engr. and City Surv., 64 Buchanan Pl., University Heights, New York City		June 1, 1881
Haines, Caspar Wistar. 322 Arcade Bldg., Philadelphia, Pa	Jun.	Feb. 2, 1876
	M.	Oct. 7, 1891
Haines, Henry Stevens. Villa Gascoyne, Alassio, Italy		Nov. 2, 1887
Hains, Peter Conover. Brig.-Gen., U. S. A. (*Retired*); Cons. and Civ. Engr., Union Trust Bldg., Washington, D. C.		April 2, 1890
Hale, Richard Augustus. Prin. Asst. Engr., Essex Co., Lawrence, Mass	Jun.	Feb. 6, 1884
	M.	July 1, 1891
Hall, Benjamin Mortimer. Chf. Engr., Porto Rico Irrig. Service, Guayama, Porto Rico		Feb. 6, 1901
Hall, Henry Arthur. 4306 North 26th St., Tacoma, Wash		May 7, 1902
Hall, John Lincoln. Second Vice-Pres., Purdy & Henderson, 609 Crary Bldg., Seattle, Wash		July 10, 1907
Hall, Julien Astin. Cons. Engr., Wenonda, Pittsylvania Co., Va.		June 5, 1889
Hall, William Hammond. Cons. Engr., 324 Haight St., San Francisco, Cal		Jan. 2, 1884
Hall, William McLaurine. Union Trust Bldg., Parkersburg, W. Va		Dec. 6, 1893
Hallihan, John Philip. Care, Chas. B. Eddy, 68 William St., New York City	Assoc. M.	April 4, 1900
	M.	June 5, 1906
Hallock, James Currie. Chf. Engr.'s Asst., Dept. of Public Works, City Hall, Newark, N. J.		Oct. 3, 1906
Hallsted, James Cottle. Cons. Engr., 1121 The Rookery, Chicago, Ill		Jan. 4, 1905
Ham, William Hale. Cons. Engr., Albany Bldg., Boston, Mass	Assoc. M.	Nov. 5, 1902
	M.	Sept. 3, 1907
Hambleton, Francis Henry. Cons. Engr., Consolidated Gas Co., Baltimore, Md		Mar. 5, 1873
Hamilton, John Wilson. (Hamilton & Chambers, Engrs. and Contrs.), 29 Broadway, New York City		July 10, 1907
Hamilton, William Gaston. 105 East 21st St., New York City		Oct. 7, 1868
Hamlin, George Herbert. Bangor, Me		July 3, 1895
Hamlin, Homer. City Engr., Los Angeles, Cal		May 4, 1904

		Date of Membership
Hammatt, Edward Augustus White. Civ. and Cons. Engr., Hyde Park, Mass.		June 5, 190
Hammatt, William Cushing. Chf. Engr., Miller & Lux, Inc., and San Joaquin & Kings River Canal & Irrig. Co., Inc., 1313 Merchants Exchange, San Francisco, Cal.	Assoc. M.	Sept. 5, 1906
	M.	Oct. 5, 1909
Hammond, Alonzo John. Civ. and Hydr. Engr., 122 South Main St., Room 207, South Bend, Ind.		June 1, 1904
Hammond, Charles Adrian. 301 South 4th Ave., Mt. Vernon, N. Y.		April 6, 1909
Hammond, George Tillinghast. 156 Berkeley Pl., Brooklyn, N. Y.		Feb. 7, 1906
Hammond, John Farnsworth. Pres., Hammond & Sloane, Inc., Engrs. and Contrs., 60 Wall St., New York City.		Feb. 7, 1906
Hancock, Robert Rives. Secy. of The Philippine Ry. Co., 43 Exchange Pl., New York City.		Dec. 1, 1908
Hand, Franklin Clark. Chf. Engr., Oklahoma Central Ry., Purcell, Okla.		Feb. 6, 1907
Handbury, Thomas Henry. Col., Corps of Engrs., U. S. A. (*Retired*), Woodley Inn, Washington, D. C.		Feb. 3, 1904
Hanna, John Hunter. Chf. Engr., The Capital Traction Co., 36th and M Sts., Washington, D. C.	Assoc. M.	April 3, 1901
	M.	Nov. 1, 1904
Hanna, John Venable. Chf. Engr., Kansas City Terminal Ry. Co., 23d and Grand Ave., Kansas City, Mo.	Assoc. M.	May 3, 1893
	M.	April 2, 1902
Hansel, Charles. Pres., Charles Hansel & Co., 43 Wall St., New York City.		Oct. 3. 1894
Hara Aiyar, Narayana Pranatarti. Local Fund Engr., Anantapoor, Madras Presidency, India.		Dec. 5, 1906
Harahan, William Johnson. Asst. to Pres., Erie R. R., 50 Church St., New York City.	Assoc. M.	Oct. 3, 1894
	M.	Oct. 7, 1903
Hardaway, Benjamin Hurt. Contr. Engr., Columbus, Ga.		Oct. 7, 1903
Hardee, William Joseph. City Engr., Room 19, City Hall, New Orleans, La.		May 6, 1896
Harding, Chester. Maj., Corps of Engrs., U. S. A., Gatun, Canal Zone, Panama.		Oct. 4, 1905
Harding, Henry. Civ. and Hydr. Engr., Hartland Four Corners, Vt.		May 7, 1873
Harding, James Judson. Engr., Bridges and Bldgs., C., M. & P. S. Ry., Seattle, Wash.		Feb. 6, 1907
Hardy, Edward Dana. Supt. of Washington Aqueduct and Filtration Plant, Washington, D. C.		Oct. 5, 1904
Hardy, George Fiske. 309 Broadway, New York City.		Mar. 1, 1905
Hardy, Harry. Apartado 163, San José, Costa Rica.	Assoc. M.	June 1, 1892
	M.	June 1, 1909

		Date of Membership.
Haring, Alexander. Prof. of Bridge and Railway Eng., New York Univ., 2251 Aqueduct Ave., University Heights, New York City		April 4, 1906
Haring, James Smith. Crafton, Pa		Nov. 4, 1891
Harkness, George Edward. Constr. Engr., Holbrook, Cabot & Rollins Corporation, 6 Beacon St., Boston, Mass		June 1, 1909
Harley, Alfred Francis. Box 873, Jacksonville, Fla		Dec. 7, 1898
Harlow, George Richardson. 204 Hawthorn St., Edgewood, Swissvale P. O., Pa		Nov. 1, 1899
Harlow, James Hayward. Chf Engr., Susquehanna Power Co., Darlington, Md		Mar. 4, 1874
Harman, Eugene Leonard. U. S. Asst. Engr., Custom House, Nashville, Tenn		Oct. 3, 1906
Harper, Edgar Ambler. 429 W. 11th St., Kansas City, Mo		June 7, 1905
Harper, John Lyell. Chf. Engr., Niagara Falls Hydr. Power & Mfg. Co., Niagara Falls, N. Y		June 5, 1907
Harrington, Ephraim. Cons. and Advisory Engr., 20 Pemberton Sq., Boston, Mass		Mar. 3, 1897
Harrington, Ferdinand Finney. Engr. of Structures, Virginian Ry. Co., Norfolk, Va	Assoc. M. M.	May 3, 1899 Feb. 2, 1909
Harrington, John Lyle. (Waddell & Harrington, Cons. Engrs.), 1012 Baltimore Ave., Kansas City, Mo	Jun. Assoc. M. M.	Aug. 31, 1897 Oct. 4, 1899 Dec. 1, 1903
Harris, Elmo Golightly. Prof. of Civ. Eng., Mo. School of Mines, Rolla, Mo		Oct. 2, 1901
Harris, Stephen. 7217 Boyer St., Mt. Airy, Philadelphia, Pa.		June 4, 1902
Harris, Van Alen. Constr. Engr., Central Fortuna, Ponce, Porto Rico	Jun. Assoc. M. M.	Nov. 6, 1894 Oct. 5, 1898 Sept. 6, 1904
HARRISON, CHARLES LEWIS. (*Director*). Deputy Chf. Engr., Board of Water Supply, 299 Broadway, New York City		Mar. 2, 1898
Harrison, Edlow Wingate. Civ. and Cons. Engr., 15 Exchange Pl., Jersey City, N. J		June 3, 1885
Harrison, Edmund Pendleton Hunter. Vice-Pres., Eyre-Shoemaker, Inc., 900 Arcade Bldg., Philadelphia, Pa		May 1, 1907
HARROD, BENJAMIN MORGAN. (*Past-President*). Cons. Engr., 1637 Foucher St., New Orleans, La		April 4, 1877
Harroun, Philip Embury. Hydr. Engr., Berkeley, Cal		Mar. 7, 1900
Harte, Charles Rufus. Asst. Engr., N. Y., N. H. & H. R. R., Room 308, R. R. Bldg., New Haven, Conn	Jun. Assoc. M. M.	April 4, 1899 May 2, 1900 Nov. 5, 1907
Hartigan, Frederick Lawrence. Care, Edison Portland Cement Co., St. James Bldg., New York City	Assoc. M. M.	May 6, 1903 Mar. 31, 1908

			Date of Membership.
	HARTRICK, EDWARD MACAULAY. U. S. Asst. Engr., River and Harbor Impvts., Galveston, Tex		Feb. 1, 1899
R.	HARTS, WILLIAM WRIGHT. Maj., Corps of Engrs., U. S. A., Custom House, Nashville, Tenn.	Assoc. M. M.	Oct. 2, 1895 April 6, 1898
	HARTWELL, HARRY. Asst. Engr., Sanderson & Porter, 52 William St., New York City	Jun. Assoc. M. M.	Jan. 2, 1894 Feb. 2, 1898 Jan. 3, 1907
	HARTWELL, HERBERT CLIFFORD. Asst. Engr., Bost. Elev. Ry. Co., 101 Milk St., Boston, Mass		Oct. 7, 1908
	HARWOOD, GEORGE ALEC. Chf. Engr., Elec. Zone Impvts., N. Y. C. & H. R. R. R., Grand Central Station, New York City	Assoc. M. M.	Feb. 5, 1902 Feb. 5, 1907
	HASBROUCK, CHARLES ALFRED. Care, Am. Bridge Co. of N. Y., Commercial Nat. Bank Bldg., Chicago, Ill	Assoc. M. M.	Feb. 3, 1892 Dec. 5, 1894
	HASKELL, EUGENE ELWIN. Director, Coll. of Civ. Eng., Cornell Univ., Ithaca, N. Y		Sept. 7, 1898
	HASKINS, WILLIAM JEWETT. Cons. Engr. and Contr., 50 Church St., Room 469, New York City	Jun. M.	Mar. 7, 1883 Dec. 1, 1886
	HASLAM, ERWIN ERNEST. Div. Engr., State Water Supply Comm., Lyon Blk., Albany, N. Y.		July 1, 1909
	HASSKARL, JOSEPH FREDERICK. Asst. Director, Dept. of Wharves, Docks and Ferries (Res., 1603 Girard Ave.), Philadelphia, Pa	Assoc. M. M.	Mar. 5, 1902 Nov. 1, 1904
	HATCH, FREDERICK THOMAS. Chf. Engr., Vandalia R. R., 850 Century Bldg., St. Louis, Mo		Dec. 4, 1889
	HATCH, JAMES NOBLE. Structural Engr. for Sargent & Lundy, 1720 Railway Exchange, Chicago, Ill		Dec. 7, 1904
	HATTON, THOMAS CHALKLEY. Cons. Engr., Wilmington, Del.		Mar. 6, 1895
	HAUGH, JAMES CHARLES. Res. Engr., New Orleans & North Eastern R. R., Press and Levee Sts., New Orleans, La.		Feb. 2, 1909
	HAUPT, LEWIS MUHLENBERG. Cons. Engr., 107 North 35th St., Philadelphia, Pa		June 6, 1888
	HAVEN, WILLIAM APPLETON. Inspecting Engr., Erie R. R., Room 10, Erie R. R. Depot, Buffalo, N. Y.		Mar. 5, 1873
	HAVILAND, ARTHUR. Engr., Land & Tax Dept., N. Y. C. & H. R. R. R. Co., 335 Madison Ave., Room 1102, New York City	Jun. M.	Jan. 4, 1882 Jan. 4, 1888
	HAWGOOD, HARRY. Cons. Engr., 722 H. W. Hellman Bldg., Los Angeles, Cal		May 4, 1909
	HAWKS, JAMES DUDLEY. Pres., Detroit & Mackinac Ry., Majestic Bldg., Detroit, Mich		Dec. 3, 1884
	HAWKSLEY, KENNETH PHIPSON. Caxton House, Westminster, S. W., London, England		May 6, 1903
	HAWLEY, JOHN BLACKSTOCK. Cons. Engr., Fort Worth, Tex	Assoc. M. M.	May 1, 1895 Oct. 5, 1898

		Date of Membership.
Hawley, William Chauncey. Chf. Engr. and Gen. Supt., Pennsylvania Water Co., 701 Wood St., Wilkinsburg, Pa.	Jun. Assoc. M. M.	Oct. 1, 1890 April 6, 1892 Dec. 3, 1902
Hawxhurst, Robert, Jr. Cons. Engr., 62 London Wall, London, E. C., England	Assoc. M. M.	Sept. 7, 1904 Dec. 3, 1907
Hayden, John Bruce. Engr. of Bridges, M. of W. Dept., N. Y. C. & H. R. R. R., Grand Central Palace, New York City	Assoc. M. M.	May 2, 1900 May 5, 1908
Hayden, William Wallace. Chf. Engr., Lake View Traction Co., N. Memphis Savings Bank, Memphis, Tenn.		Nov. 6, 1895
Hayes, Edmund. 816 Fidelity Bldg., Buffalo, N. Y.	Jun. M.	April 3, 1878 Mar. 5, 1884
Hayes, Edward. Cons. Engr., 113 Dryden Rd., Ithaca, N. Y.		June 5, 1901
Hayes, George Samuel. 1123 Broadway, New York City	Jun. Assoc. M. M.	Dec. 6, 1892 June 3, 1896 Sept. 2, 1903
Hayes, Henry Wilde. Mass. Engr. of Grade Crossings, 8 Beacon St., Boston, Mass.	Assoc. M. M.	Mar. 2, 1898 May 1, 1901
Hayes, Stanley Wolcott. Pres., Hayes Track Appliance Co., Geneva, N. Y.		June 6, 1900
Hayford, John Fillmore. Director, Coll. of Eng., Northwestern Univ., Evanston, Ill.	Assoc. M. M.	May 6, 1896 April 2, 1907
Hays, John Willis. 3 South Adams St., Petersburg, Va.		June 5, 1901
Hayt, Stephen Thurston, Jr. Chf. Engr., Susq. & N. Y. R. R. Co., 11 Trinity Pl., Williamsport, Pa.		Mar. 3, 1897
Hayward, Robert Francis. Gen. Mgr., Western Canada Power Co., Ltd., Vancouver, B. C., Canada		July 10, 1907
Hazard, Schuyler. Gen. Mgr. and Chf. Engr., Orleans County Quarry Co., Albion, N. Y.		Oct. 5, 1898
Hazelton, Charles William. Engr. and Treas., Turners Falls Co. (Water Power), Turners Falls, Mass.		Jan. 7, 1891
Hazen, Allen. (Hazen & Whipple, Cons. Engrs.), 103 Park Ave., New York City	Assoc. M. M.	June 3, 1896 Mar. 6, 1900
Hazen, William Nelson. Engr., Expanded Metal Eng. Co., Union Bldg., Newark, N. J.	Assoc. M. M.	Dec. 3, 1902 Nov. 8, 1909
Hazlehurst, George Blagden. Cons. Engr., Catonsville, Md.		Feb. 1, 1888
Hazlehurst, James Nisbet. Cons. Engr., 532 Candler Bldg., Atlanta, Ga		Oct. 4, 1899
Heald, Simpson Clark. Rockwood St., Jamaica Plain, Mass.		Nov. 4, 1885
Healy, John Francis. Gen. Mgr., Operating Dept., Davis Colliery Co., Elkins, W. Va.	Jun. Assoc. M. M.	Jan. 2, 1890 June 3, 1891 Nov. 1, 1899
Hedges, Samuel Hamilton. Pres., Puget Sound Bridge & Dredging Co., 432 Central Bldg., Seattle, Wash.		July 10, 1907

		Date of Membership.
Hedrick, Ira Grant. Cons. Engr., 309 Keith & Perry Bldg., Kansas City, Mo.	Jun. Assoc. M. M.	Oct. 3, 1893 June 2, 1897 Nov. 7, 1900
Hegardt, Gustave Bernard. (Hegardt & Clarke), 1010 Board of Trade Bldg., Portland, Ore.		Oct. 7, 1908
Heldt, Hans Ludwig. Supt., The Sombrerete Min. Co., Sombrerete, Zac., Mexico		June 5, 1907
Hench, Norman MacPherson. Engr., Track Appliances, Carnegie Steel Co., Carnegie Bldg., Pittsburg, Pa.		May 2, 1906
Henderer, William Oswald. Vice-Pres., The Osborn Eng. Co., Osborn Bldg., Cleveland, Ohio		April 3, 1901
Henderson, John Baillie. Govt. Hydr. Engr., Water Supply Dept., Brisbane, Queensland, Australia		June 4, 1890
Henderson, John Thomas. Deputy Chf. Engr., Conn. River Bridge and Highway Dist., 756 Main St., Hartford, Conn.	Assoc. M. M.	Sept. 3, 1902 Sept. 3, 1907
Hendrick, Calvin Wheeler. Chf. Engr., Baltimore Sewerage Comm., American Bldg., Baltimore, Md.		Nov. 7, 1900
Hengst, Robert Graham. Mgr. for Jno. B. Carter Co., Railroad Contrs., Marion, Ill.	Assoc. M. M.	Oct. 7, 1903 May 5, 1908
Henny, David Christiaan. Cons. Engr., U. S. Reclamation Service, Beck Bldg., Portland, Ore.		Sept. 7, 1887
Henry, Philip Walter. Cons. Engr., 90 West St., New York City	Assoc. M. M.	Jan. 3, 1894 Nov. 2, 1908
Hepburn, Frederick Taylor. Gen. Mgr., Lima & Toledo Traction Co. and Indiana, Columbus & Eastern Traction Co., Lima, Ohio		June 6, 1906
Herbert, Arthur Powis. Apartado 127, Colima, Col., Mexico.		Sept. 5, 1888
Herbert, Harry Monmouth. Cons. Engr.; Member, New Jersey State Board of Health and Chf., Div. of Sewerage and Water Supplies; Cons. Engr., Topeka-Southwestern Ry., Bound Brook, N. J.		April 6, 1898
Hering, Rudolph. Hydr. and San. Engr., 170 Broadway, New York City		Jan. 5, 1876
Hermann, Edward Adolph. Pres., Reliance Quarry & Constr. Co., 1026 Langdon St., Alton, Ill.		April 6, 1887
Herrick, Henry Augustus. Hydr. and Mill Engr., 45 Milk St., Boston, Mass.; Res., 242 Prospect St., Manchester, N. H.		May 7, 1890
Herring, Willard E. Dist. Engr., U. S. Forest Service, Portland, Ore.	Assoc. M. M.	Sept. 4, 1901 Jan. 3, 1907
Herrmann, Frederick Charles. Chf. Engr., California Development Co., Calexico, Cal.		Nov. 6, 1907
Herron, John. 188 Bryant St., Palo Alto, Cal.		Oct. 4, 1893
R. Herschel, Clemens. Hydr. Engr., 2 Wall St., New York City.		April 21, 1869
Hesse, Fred. 471 East Alder St., Portland, Ore.		June 3, 1908

		Date of Membership.
Heuer, William Henry. Col., Corps of Engrs., U. S. A., 918 Pacific Bldg., San Francisco, Cal		Mar. 3, 1880
Hewes, Virgil Henry. Mgr. and Treas., The Zwoyer Fuel Co., 60 Wall St., Room 2602 (Res., 161 West 103d St.), New York City		Feb. 3, 1904
Hewett, Bertram Henry Majendie. Pennsylvania Terminal, 7th Ave. and 32d St., New York City	Assoc. M. M.	April 5, 1905 Oct. 1, 1907
Hewett, William Sherman. Box 1004, Minneapolis, Minn		June 1, 1909
Hewins, George Sanford. Care, J. G. White & Co., North Fork, Madera Co., Cal		Oct. 7, 1908
Hewitt, Charles Edward. Trenton, N. J		Oct. 5, 1887
Hickok, Henry Addison. Cons. and Const. Engr., Union Bldg., Newark, N. J		Oct. 7, 1896
Hider, Arthur. U. S. Asst. Engr.; Res. Engr. in Local Chg. of Impvts., Lake Providence Reach, Mississippi River, Greenville, Miss		Sept. 7, 1881
Higgins, George. Lecturer in Civ. Eng., Melbourne Univ., Melbourne, Victoria, Australia		Oct. 2, 1907
Higgins, Horace Longuet. Pres. and Engr.-in-Chf., The Manila R. R. Co., Manila, Philippine Islands		May 2, 1906
Hilgard, Karl Emil. Prof.; Cons. Civ. Engr., 18 Steinwiesstrasse, Zurich, V., Switzerland		June 4, 1890
Hill, Albert Banks. Cons. Civ. Engr., 100 Crown St., New Haven, Conn	Jun. M.	Feb. 2, 1876 Mar. 5, 1884
Hill, Cicero Demerit. 1722 W. 101st St., Chicago, Ill		April 4, 1906
Hill, Curtis. State Highway Engr., Columbia, Mo.	Assoc. M. M.	Oct. 2, 1901 Jan. 3, 1907
Hill, Ernest Rowland. Asst. to Chf. Engr. of Elec. Traction, P. T. & T. R. R. Co., 10 Bridge St., New York City		July 10, 1907
Hill, George. Builder, 31 East 27th St., New York City	Assoc. M. M.	Oct. 4, 1893 Feb. 1, 1899
Hill, Henry Francis. 12 Allen Bldg., Augusta, Me		Mar. 6, 1907
Hill, John Edward. Prof. of Civ. Eng., Brown Univ., Providence, R. I	Assoc. M. M.	May 4, 1892 Mar. 31, 1908
Hill, John Willmuth. Cons. Engr., First National Bank Bldg., Cincinnati, Ohio	Jun. M.	Feb. 3, 1875 April 5, 1876
Hill, Louis Clarence. Phœnix, Ariz		Oct. 4, 1905
Hill, Walter Hovey. Cons. Engr., Grangeville, Idaho		June 5, 1901
Hill, William Ryan. Cons. Engr., 53 State St., Albany, N. Y.		July 1, 1891
Hilliard, Foster Haven. U. S. Asst. Engr.; Supt. of Dredging Operations with the Mississippi River Comm., Box 1017, Memphis, Tenn.	Assoc. M. M.	Mar. 6, 1901 May 1, 1906
Hillyer, William Ross. Asst. Commr. of Public Works, Borough of Richmond, City of New York, Borough Hall, St. George (Res., Palmer Ave., Port Richmond), N. Y.		May 6, 1903

		Date of Membership.
Himes, Albert James. Engr. of Grade Elimination, N. Y., C. & St. L. R. R. Co., Hickox Bldg., Cleveland, Ohio	Assoc. M. M.	Nov. 6, 1895 June 7, 1899
Himmelwright, Abraham Lincoln Artman. Gen. Mgr., The Roebling Constr. Co., 949 Broadway, New York City		Oct. 5, 1898
Hinckley, Howard Vernon. Cons. Engr., 1018 North Harvey, Oklahoma City, Okla		Dec. 5, 1883
Hinckley, John Franklin. Cons. Engr., 1423 Syndicate Trust Bldg., St. Louis, Mo		May 6, 1885
Hindes, Stetson George. Pres., San Francisco Bridge Co., 865 Monadnock Bldg., San Francisco, Cal		June 3, 1903
Hinds, Franklin Allen. Cons. Engr., 28 Flower Bldg., Watertown, N. Y		May 3, 1899
Hiroi, Isami. Care, Coll. of Eng., Tokyo Imperial Univ., Tokyo, Japan		Dec. 1, 1908
Hitchcock, Frederick Collamore. Vice-Pres. and Gen. Mgr., MacArthur Bros. Co., 11 Pine St., New York City	Assoc. M. M.	Mar. 7, 1894 Feb. 6, 1895
Hittell, John Benjamin. Chf. Engr. of Streets, Board of Local Impvts., 300 City Hall (Res., 832 Leland Ave.), Chicago, Ill		July 1, 1909
Hoag, Sidney Willett, Jr. Deputy Chf. Engr., Dept. of Docks and Ferries, Pier A, North River, New York City		Sept. 2, 1885
Hobby, Arthur Stanley. Cons. Engr., Arcade Bldg., Philadelphia, Pa	Assoc. M. M.	Sept. 4, 1901 June 4, 1907
Hobson, Joseph. 346 Bay St. (South), Hamilton, Ont., Canada		Feb. 5, 1890
Hocke, Julius George. Secy. and Treas., Gen. Contr. & Eng. Co., 50 Church St., New York City (Res., 669 Ave. C, Bayonne, N. J.)		April 3, 1907
Hodgdon, Frank Wellington. Chf. Engr., Mass. Board, Harbor and Land Commrs., Room 131, State House, Boston, Mass.		Dec. 3, 1884
Hodge, Harry Seymour. Vice-Pres., Detroit Twist Drill Co., 83 Alfred St., Detroit, Mich		Oct. 3, 1894
Hodge, Henry Wilson. (Boller & Hodge, Cons. Engrs.), 149 Broadway, New York City	Jun. M.	Jan. 5, 1887 Oct. 2, 1895
Hodges, Gilbert. Cons. Engr., Medford, Mass		June 4, 1890
Hodges, Harry Foote. Lt.-Col., Corps of Engrs., U. S. A.; Member and Asst. Chf. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama		Mar. 4, 1903
Hoff, Olaf. Cons. Engr., 149 Broadway, New York City		May 6, 1885
Hoffman, Nathaniel Baker Klink. Asst. Engr., Bureau of Sewers, Borough of the Bronx, 2683 Creston Ave., New York City		Nov. 6, 1901

		Date of Membership.
Hoffmann, Robert. Chf. Engr., Dept. of Public Service (Res., 1871 East 87th St.), Cleveland, Ohio	Assoc. M. M.	June 5, 1901 Sept. 6, 1904
Hogeland, Albert Harrison. Chf. Engr., G. N. Ry., St. Paul, Minn		May 2, 1906
Hogg, James Breading. Civ. and Min. Engr., Connellsville, Pa.		Oct. 3, 1906
Hohl, Leonhard John. Cons. Engr., 1834 Delaware St., Berkeley, Cal		Oct. 5, 1904
Holbrook, Elliot. Special Engr., U. P. System and S. P. Co., 135 Adams St., Chicago, Ill		Sept. 3, 1902
Holbrook, Frank Dudley. U. S. Asst. Engr., Wellsburg, W. Va	Assoc. M. M.	Feb. 1, 1905 Jan. 7, 1908
Holbrook, Frederick William Doane. Navy Yard, Puget Sound, Bremerton, Kitsap Co., Wash		Oct. 6, 1886
Holbrook, John Byers. Cons. Engr., 3 South William St., New York City		April 6, 1909
Holcombe, Joseph Gales. Chf. Engr. and Director of Public Works, Panama, Panama		May 4, 1904
Holden, Edward Henry. Asst. Engr., Topographical Bureau, Borough of the Bronx, 177th St. and 3d Ave. (Res., 1074 Boston Rd.), Bronx, New York City		May 6, 1908
Holgate, Henry. Cons. Engr. (Ross & Holgate), 80 St. François Xavier St., Montreal, Que., Canada		Oct. 2, 1901
Hollyday, Richard Carmichael. Civ. Engr., U. S. N.; Chf. of Bureau of Yards and Docks, Navy Dept., Washington, D. C		Sept. 2, 1903
Holman, Minard Lafever. Cons. Engr. (Holman & Laird), 3744 Finney Ave., St. Louis, Mo		April 2, 1884
Holmes, Glenn Dickinson. Chf. Engr., Intercepting Sewer Board, Room 112, Court House, Syracuse, N. Y	Assoc. M. M.	June 5, 1901 Mar. 5, 1907
Holmes, Howard Carleton. Cons. Engr.; Chf. Engr., San Francisco Dry Dock Co.; Chf. Engr., S. F., O. & S. J. Ry.; Cons. Engr., Docks and Wharfs, West. Pac. Ry., Room 804, Santa Marina Bldg., San Francisco, Cal		Nov. 4, 1903
Holt, Herbert Samuel. 297 Stanley St., Montreal, Que., Canada		Mar. 6, 1889
Homberger, Heinrich. Cons. Engr., Room 864, Pacific Bldg., San Francisco, Cal		Oct. 5, 1909
Hone, Frederic de Peyster. (Chambers & Hone), 1 Liberty St., New York City	Jun. Assoc. M. M.	April 4, 1899 Feb. 5, 1902 May 5, 1908
Honens, Frederick William. U. S. Asst. Engr., U. S. Engr. Office, Postal Telegraph Bldg. (Res., 3917 Belleview Ave.), Kansas City, Mo	Assoc. M. M.	April 3, 1901 May 31, 1904

		Date of Membership.
Hood, Richard Haden. 541 Stelle Ave., Plainfield, N. J.	Assoc. M. M.	May 3, 1893 Nov. 2, 1898
Hood, William. Chf. Engr., S. P. Co., Room 1136, James Flood Bldg., San Francisco, Cal.		Oct. 7, 1896
Hook, Charles Addison. Civ. and Cons. Engr., 400 East Madison St., Baltimore, Md.		Jan. 3, 1900
Hook, Gulian Schmalz. Civ. Engr., Gen. Elec. Co., Schenectady, N. Y.		April 3, 1901
Hoover, Herbert Clark. Red House, Hornton St., London, England		Jan. 4, 1910
Hoover, Joseph Warren. 513 New York Life Bldg., Kansas City, Mo.		June 6, 1888
Hopkins, Charles Comstock. (Knight & Hopkins, Hydr. and San. Engrs.), Rome, N. Y.		June 4, 1890
Hopkins, Stephen Upshur. Engr., 6th Div., Public Service Comm., 23 Flatbush Ave., Brooklyn, N. Y.		Oct. 5, 1909
Hopson, Ernest George. Superv. Engr., U. S. Reclamation Service, Portland, Ore.		July 10, 1907
Horn, Frank Churchill. Const. Engr., Twin Falls Salmon River Land & Water Co., Twin Falls, Idaho		Sept. 1, 1903
Hornsby, Robert Wright. Casilla 73D, Santiago, Chili		Nov. 4, 1908
Horton, George Terry. Engr. and Mgr., Chicago Bridge & Iron Works, 105th and Throop Sts., Chicago, Ill.		April 6, 1904
Horton, Horace E. Prop., Chicago Bridge & Iron Works, Chicago, Ill.		Sept. 6, 1882
Horton, Theodore. Chf. Engr., New York State Dept. of Health, Albany, N. Y.	Jun. Assoc. M. M.	Aug. 31, 1897 April 4, 1900 June 6, 1905
Hotchkiss, Charles Wilcox. Gen. Mgr., Chic., Ind. & South. R. R., 411 La Salle St. Station, Chicago, Ill.		Jan. 5, 1898
Hotchkiss, Louis Jenison. Asst. Bridge Engr., C., B. & Q. R. R., 209 Adams St., Chicago, Ill.		Nov. 30, 1909
Hough, David Leavitt. Pres., The United Eng. & Contr. Co., and The Cuban Eng. & Contr. Co., 17 West 42d St., New York City		May 5, 1897
Hough, Ulysses B. Engr. for Bunker Hill & Sullivan Min. & Concentrating Co., 415 Hyde Blk., Spokane, Wash.		Nov. 5, 1902
House, Francis Edwin. Pres., D. & I. R. R. R. Co., Duluth, Minn.		May 1, 1895
Houston, Gavin Nelson. Cons. and Superv. Engr., 518 Commonwealth Bldg., Denver, Colo.	Jun. Assoc. M. M.	May 4, 1897 Nov. 7, 1900 Feb. 2, 1909
Hovey, Otis Ellis. Asst. Chf. Engr., Am. Bridge Co. of N. Y., 30 Church St., New York City	Assoc. M. M.	April 4, 1894 Jan. 3, 1900
Howard, Charles Pope. Asst. Engr., L. S. & M. S. Ry., Cleveland, Ohio	Assoc. M. M.	Jan. 3, 1894 Oct. 31, 1905

		Date of Membership.
Howard, Frederick Billings. Grosse Ile, Wayne Co., Mich.	Jun. M.	Mar. 3, 1875 Nov. 6, 1878
Howard, John Lewis. Prin. Asst. Engr., Charles River Basin Comm., 367 Boylston St., Boston, Mass.	Assoc. M. M.	Dec. 7, 1898 April 2, 1902
Howe, Edward Willard. Asst. Engr., Eng. Dept., 65 City Hall, Boston, Mass.		Sept. 7, 1887
Howe, George Edward. Met. Water Board, Boston, Mass.	Assoc. M. M.	Mar. 4, 1903 April 30, 1907
Howe, Horace Joseph. Care, Am. Soc. C. E., 220 West 57th St., New York City	Jun. M.	May 2, 1888 Mar. 2, 1898
Howe, Joseph Milton. Cons. Engr. (Howe & Wise), 231 Commercial Bank Bldg., Houston, Tex.	Assoc. M. M.	Feb. 4, 1903 Jan. 7, 1908
Howe, Malverd Abijah. Prof., Civ. Eng., Rose Polytechnic Inst., 2108 North 10th St., Terre Haute, Ind.	Assoc. M.	May 7, 1890 Jan. 1, 1896
Howe, William Bell White. Cons. Engr., Spartanburg, S. C.		Mar. 1, 1893
Howell, David Janney. Union Trust Bldg., 15th and H Sts., N. W., Washington, D. C.		Sept. 5, 1900
Howell, Franklin Davinport, Jr. The Pacific Co., Civ. and Min. Engrs., 424 Central Bldg., Los Angeles, Cal.		June 5, 1901
Howell, George Pierce. Maj., Corps of Engrs., U. S. A., U. S. Engr. Office, Galveston, Tex.		Feb. 2, 1909
Howells, Julius Merriam. Hydr. Engr.; Care, English-American Club, Lausanne, Switzerland		June 4, 1902
Hoxie, Richard Leveridge. Brig.-Gen., U. S. A. (*Retired*), 1632 K St., N. W., Washington, D. C.		June 2, 1886
Hoyt, John Clayton. Asst. Chf. Hydrographer, U. S. Geological Survey, 1330 F St., N. W., Washington, D. C.	Assoc. M. M.	May 4, 1904 June 1, 1909
Hoyt, William Edwin. Cons. Engr. and Special Engr., N. Y. C. & H. R. R. R. Co. (Res., 50 Westminster Rd.), Rochester, N. Y.		Mar. 5, 1884
Hubbard, Isaac Wendell. (Pugh & Hubbard), 601 Witherspoon Bldg., Philadelphia, Pa.	Assoc. M. M.	Mar. 1, 1905 Jan. 4, 1910
Hubbell, Clarence William. City Engr., Manila, Philippine Islands	Jun. Assoc. M. M.	May 31, 1898 April 4, 1900 Jan. 5, 1904
Hudson, Clarence Walter. Prof. of Civ. Eng., Polytechnic Inst. of Brooklyn; Cons. Engr., 45 Broadway, New York City	Assoc. M. M.	Nov. 7, 1894 Feb. 7, 1900
Hudson, John Rogers. 5353 Minerva Ave., St. Louis, Mo.		May 4, 1887
Huggins, William. Posta Restante, Santos, Brazil		Feb. 7, 1906
Hughes, David Edward. U. S. Asst. Engr., San Pedro, Cal.		Sept. 6, 1905

		Date of Membership.
Hughes, Hector James. Asst. Prof. of Civ. Eng., Harvard Univ., and Cons. Engr., 114 Pierce Hall, Cambridge, Mass.		May 3, 1905
Hughes, William Mackenzie. Cons. Bridge Engr., 532 Postal Telegraph Bldg., Chicago, Ill.		June 2, 1880
Humphrey, Richard Lewis. Cons. Engr., 805 Harrison Bldg., Philadelphia, Pa.	Assoc. M. M.	May 5, 1897 May 3, 1904
Humphreys, Alexander Crombie. Pres., Humphreys & Glasgow, Inc., Buffalo Gas Co., and Stevens Inst. of Tech., 165 Broadway, New York City		Mar. 6, 1895
Humphreys, David Carlisle. Dean and Prof. of Civ. Eng., Washington and Lee Univ., Lexington, Va.		Nov. 2, 1887
Hunt, Andrew Murray. Cons. Engr., Union Trust Bldg., San Francisco, Cal.		Feb. 7, 1906
HUNT, CHARLES WARREN. (*Secretary*). 220 West 57th St. (Res., 171 West 88th St.), New York City		Jan. 2, 1884
Hunt, Conway Bethune. Engr. of Highways, District of Columbia, District Bldg. (Res., 1815 M St., N. W.), Washington, D. C.		Feb. 4, 1891
Hunt, Robert Woolston. Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill.		June 3, 1885
Hunt, Rufus Cameron. Civ. Engr. and Contr., Washington Court House, Ohio		Oct. 5, 1904
Hunter, John Burnap. Engr. and Member of Board of Public Works, 351 Broadway, Denver, Colo.		June 3, 1908
Hunter, William. Chf. Engr., P. & R. Ry., Room 520, Reading Terminal, Philadelphia, Pa.		June 5, 1895
Hunter, William Henry. Chf. Engr., Manchester Ship Canal, 41 Spring Gardens, Manchester, England		Feb. 7, 1906
Hurry, Edward Henry. Goodwyns, Haslemere, England		June 1, 1898
Huss, George Morehouse. 909 West Franklin Ave., Minneapolis, Minn.		May 1, 1907
Hussey, Ernest Bertrand. 1011 Alaska Bldg., Seattle, Wash.		July 1, 1908
Hutchings, William Evelyn. 824 Barrett Ave., Louisville, Ky.		June 7, 1899
Hutchins, Jere Chamberlain. Pres., Detroit United Ry., 12 Woodward Ave., Detroit, Mich.	Assoc. M. M.	Mar. 2, 1898 April 4, 1900
Hutchinson, Cary Talcott. Cons. Engr., 60 Wall St., New York City	Assoc. M. M.	Mar. 4, 1896 Mar. 1, 1904
Hutchinson, George Hunt. Chf. Engr., North Western Fuel Co., Pioneer Press Bldg., St. Paul, Minn.	Assoc. M. M.	Sept. 2, 1891 June 7, 1893
Hyde, Abraham Lincoln. Asst. Prof. of Bridge Eng., Univ. of Missouri, Columbia, Mo.	Assoc. M. M.	April 5, 1893 Oct. 6, 1897

		Date of Membership.
Hyde, Charles Gilman. San. and Hydr. Engr.; Prof., San. Eng., Civ. Eng. Bldg., Univ. of California, Berkeley, Cal.	Assoc. M. M.	April 2, 1902 June 1, 1909
Ingalls, Owen Lovejoy. Engr. in Chg. of Manila Sewerage System, Manila, Philippine Islands	Jun. M.	Mar. 5, 1890 June 4, 1902
Ingersoll, Colin Macrae, Jr. Advisory Engr., 165 Broadway, Room 2127, New York City		June 5, 1895
Irwin, James Clark. Chf. Engr., Rutland R. R. Co., Rutland, Vt.	Jun. Assoc. M. M.	April 4, 1893 Dec. 7, 1898 June 6, 1900
Isaacs, John Dove. Cons. Engr., Harriman Lines, 135 Adams St., Chicago, Ill.		Mar. 7, 1894
Ives, Arthur Stanley. Asst. Gen. Mgr., Poughkeepsie Light, Heat & Power Co., Poughkeepsie, N. Y.	Jun. Assoc. M. M.	Jan. 7, 1896 Jan. 3, 1900 May 7, 1902
Jackson, Dugald Caleb. Prof. of Elec. Eng., Mass. Inst. Tech.; Cons. Engr., Boston, Mass.		Nov. 2, 1898
Jackson, Thomas Herbert. Capt., Corps of Engrs., U. S. A., 1005 Hooker & Lent Bldg., San Francisco, Cal.		Mar. 4, 1908
Jackson, Thomas Moore. Pres., West Va. Short Line R. R., Clarksburg, W. Va.		June 3, 1891
Jackson, William. City Engr., 50 City Hall, Boston, Mass.		Sept. 3, 1884
Jackson, William Benjamin. (D. C. & Wm. B. Jackson, Cons. Engrs.), 508 Commercial National Bank Bldg., Chicago, Ill.		Mar. 4, 1903
Jacob, Thomas Nottingham. Chf. Engr., East Side Levee and San. Dist., 205 Sexton Bldg., East St. Louis, Ill.		May 4, 1909
Jacobs, Charles Mattathias. 30 Church St., New York City.		May 4, 1904
Jacobs, Joseph. Cons. Engr., 406 Central Bldg., Seattle, Wash.	Assoc. M. M.	Sept. 4, 1901 April 6, 1909
Jacomb-Hood, John Wykeham. Chf. Engr., Lond. & S. W. Ry., Engr.'s Office, Waterloo Station, London, S. E., England		Feb. 5, 1902
James, William Atlee. Div. Engr. of Constr., Canadian Pacific Ry., 179 Cathedral Ave., Winnipeg, Man., Canada		July 1, 1909
Jameson, Charles Davis. Superv. Engr. and Archt. to the Imperial Chinese Board of Foreign Affairs (Wai Wu Pu), Peking, China		Mar. 7, 1888
Jamieson, James Alexander. Cons. and Designing Engr., Board of Trade Bldg., Montreal, Que., Canada		May 3, 1905
Jamieson, John Quintin. 475 Hassalo St., Portland, Ore.		Nov. 6, 1889
Janes, George Portlock. 405 Third Ave. East, Roselle, N. J.		May 1, 1907

		Date of Membership
Janney, William Dean. Supt. Constr., Public Wharves and Docks, 2109 Homewood Ave., Baltimore, Md		April 1, 1896
Japp, Henry. S. Pearson & Son, Inc., 507 Fifth Ave., New York City		May 3, 1905
Jaques, William Henry. Civ. and Mech. Engr.; Pres., Hampton Water-Works Co., Little Boar's Head, N. H		July 2, 1890
Jarrett, Edwin Seton. The Foundation Co., 115 Broadway, New York City	Assoc. M. M.	May 1, 1895 April 6, 1909
Jarvis, Charles Maples. First Vice-Pres., Am. Hardware Corporation, New Britain, Conn		Jan. 7, 1885
Jaudon, Henry Scudder. Cons. Engr., Savannah Water-Works System; Address, P. O. Box 582, Savannah, Ga	Assoc. M. M.	Feb. 4, 1903 Feb. 1, 1910
Jaycox, Thomas William. Cons. Civ. Engr., Room 304, Majestic Bldg., Denver, Colo		Jan. 4, 1882
Jenkins, William Dunbar. Lock Box 317, Chattanooga, Tenn		Sept. 7, 1887
Jervey, Henry. Maj., Corps of Engrs., U. S. A., U. S. Engr. Office, Y. M. C. A. Bldg., Mobile, Ala		June 5, 1907
Jewett, William Cornell. 541 Ridgeway Ave., Cincinnati, Ohio		June 3, 1885
Johnson, Albert Lincoln. Cons. Engr., Corrugated Bar Co., 1407 New National Bank of Commerce Bldg., St. Louis, Mo	Assoc. M. M.	Sept. 2, 1896 Dec. 4, 1901
Johnson, Arthur Newhall. State Highway Engr., Springfield, Ill	Assoc. M. M.	Sept. 2, 1903 July 1, 1909
Johnson, Chapman Love. Cons. Engr., 238 Mary St., Utica, N. Y		Oct. 7, 1903
Johnson, Francis Robert. Vernon, B. C., Canada		June 1, 1898
Johnson, James Moreland. Engr. and Pres., Louisville Bridge & Iron Co., Louisville, Ky		July 1, 1891
Johnson, Lewis Elisha. Asst. to Supt., B. & C. Dept., The Pennsylvania Steel Co., Steelton, Pa	Assoc. M. M.	Nov. 4, 1896 May 1, 1901
Johnson, Lewis Jerome. Prof. of Civ. Eng., Harvard Univ., and Cons. Engr., 309 Pierce Hall, Cambridge, Mass	Assoc. M. M.	Sept. 4, 1901 Nov. 1, 1904
Johnson, Lucien Samuel. U. S. Engr. Office, Thirteen, Lee Co., Ky		Dec. 4, 1901
Johnson, Phelps. Mgr., Dominion Bridge Co., Ltd., Windsor Hotel, Montreal, Que., Canada		July 1, 1891
Johnson, Thomas H. Cons. Engr., Penn. Lines W. of Pitts., Pittsburg, Pa		Sept. 5, 1877
Johnson, William Stone. San. and Hydr. Engr., 101 Tremont St., Boston, Mass	Assoc. M. M.	June 6, 1894 May 1, 1906

		Date of Membership.
OHNSTON, ALBERT WILLIAM. Gen. Mgr., The N. Y., C. & St. L. R. R., 424 Hickox Bldg., Cleveland, Ohio		Mar. 6, 1895
OHNSTON, CLARENCE THOMAS. State Engr., Cheyenne, Wyo.		Sept. 7, 1904
OHNSTON, HORACE GREELEY. Pres. and Gen. Mgr., The Am. Well & Prospecting Co., Corsicana, Tex.		Sept. 7, 1887
OHNSTON, JOHN HOWARD. Casapalca, Bvd. Cimiez, Nice, Alpes Maritimes, France		Mar. 1, 1876
ONAH, FRANK GILBERT. Chf. Engr. of Constr., St. L. & San Fran. R. R. Co., Frisco Bldg., St. Louis, Mo.		Nov. 4, 1903
ONAS, HENRY F. Prin. Asst. to Bridge Engr., Sunset Lines in Texas and Louisiana, P. O. Box 583, Houston, Tex.		Oct. 2, 1907
ONES, ARTHUR LEWIS. 1a Calle de Iturbide 7, City of Mexico, D. F., Mexico		July 10, 1907
ONES, HOWARD MURFREE. Room 48, Cole Bldg., Nashville, Tenn.		June 1, 1909
ONES, WASHINGTON. 1632 North 15th St., Philadelphia, Pa.		Oct. 7, 1874
ONES, WILLIAM HENRY. Prin. Asst. Engr., Mo. Valley Bridge & Iron Co., 315 Vine St., Leavenworth, Kans.		May 4, 1904
ORDAN, EDWARD CLARENCE. Civ. and Hydr. Engr., 31½ Exchange St., Portland, Me.		May 7, 1890
UDD, WILBER MACAULAY. (The W. G. Wilkins Co., Engrs. and Archts.), Westinghouse Bldg., Pittsburg, Pa.		Oct. 4, 1905
UDSON, CHARLES ALBERT. Collector of Customs, Sandusky, Ohio		Jan. 3, 1894
UDSON, WILLIAM PIERSON. Cons. Engr., Broadalbin, Fulton Co., N. Y.		Sept. 7, 1881
UDSON, WILLIAM VOORHEES. Maj., Corps of Engrs., U. S. A., District Bldg., Washington, D. C.		Nov. 4, 1896
UENGST, HENRY FREDERICK. Care, Am. Water-Works & Gas Co., P. O. Box 1103, Pittsburg, Pa.		April 2, 1884
UST, GEORGE ALEXANDER. Cons. Engr.; Pres., The Geo. A. Just Co., 239 Vernon Ave., Long Island City, N. Y.	Jun. M.	Sept. 3, 1884 Mar. 4, 1891
ADONO, CHOKURO. Engr. and Director, Okura & Co., Tokyo, Japan		Jan. 8, 1902
AREISCHA, SERGE DE. Prof. of the Imperial Inst. of Engrs. of Ways and Communications; Asst. Gen. Mgr., Traffic Dept., Board of Direction, Russian Rys.; Pres., Assoc. of M. of W. Engrs., Russian Ry., Zagorodny prosp. No. 70, log 4, St. Petersburg, Russia		June 6, 1894
ASTL, ALEXANDER EDWARD. 321 Fremont St., Peekskill, N. Y.	Jun. M.	Jan. 4, 1888 Nov. 5, 1890
ATTÉ, WALTER. Cons. Engr., Irvington, N. Y.		Oct. 7, 1868
AUFFMANN, WILLIAM FREDERICK. Asst. Engr., N. Y. C. & H. R. R. R., 50 Lincoln Pl., East Rutherford, N. J.		Sept. 6, 1905

		Date of Membership.
Kaufman, Gustave. Engr. and Mgr., The Wilson & Baillie Mfg. Co., 26 Court St., Brooklyn, N. Y.		May 7, 1890
Keating, Edward Henry. (Keating & Breithaupt, Cons. Engrs.), 82 King St., E., Toronto, Ont., Canada		June 7, 1882
Keefer, Charles Henry. 49 Metcalfe St., Ottawa, Ont., Canada		Oct. 7, 1908
KEEFER, THOMAS COLTRIN. (*Past-President*). Ottawa, Ont., Canada		April 4, 1877
Keith, George Thomas. Res. Engr., Impvt. of Public Highways, Olean, N. Y.		May 4, 1881
Keith, Herbert Cary. Cons. Engr., 116 Nassau St., New York City		Dec. 4, 1889
Keller, Charles. Maj., Corps of Engrs., U. S. A.; Engr., 11th L. H. Dist., in Chg. U. S. Lake Survey, 212 Old Federal Bldg., Detroit, Mich.		Mar. 7, 1900
Keller, Charles Lincoln. First Asst. Engr., The Scherzer Rolling Lift Bridge Co., 1616 Monadnock Blk., Chicago, Ill.	Jun.	Oct. 4, 1898
	Assoc. M.	Mar. 6, 1901
	M.	Oct. 31, 1905
Kelley, Howard George. Chf. Engr., Grand Trunk Ry. System, Montreal, Que., Canada		May 1, 1889
Kelley, James Augustus. Andes, Delaware Co., N. Y.	Assoc.	Mar. 5, 1901
	Assoc. M.	Sept. 2, 1903
	M.	Mar. 3, 1908
Kelley, William Datus. Pres., Kelly & Kelley (Inc.), Engrs., Builders and Contrs.; Pres., Cowden & De Young, Inc., Elec. Contrs., 45 East 42d St., New York City		Nov. 2, 1887
Kellogg, Charles. Athens, Pa.		June 2, 1880
Kellogg, Norman Benjamin. Cons. Civ. Engr., Monadnock Bldg., San Francisco, Cal.	Jun.	Feb. 6, 1878
	M.	July 3, 1895
Kelly, Cassius William. City Engr., 17 City Hall, New Haven, Conn.	Jun.	Mar. 1, 1882
	M.	June 6, 1888
Kelsey, Louis Curtis. Salt Lake City, Utah		Mar. 2, 1909
Kendall, Charles Hanford. Rushford, N. Y.		Nov. 6, 1907
Kendrick, John William. Vice-Pres., A., T. & S. F. Ry., Railway Exchange, Chicago, Ill.		June 6, 1883
Kendrick, Julian Way. First National Bank Bldg., Birmingham, Ala.		Oct. 1, 1902
Kenly, Edward Marion. Chf. Engr., Yakima Val. Transportation Co., P. O. Box Drawer O, North Yakima, Wash.		May 4, 1904
Kenly, William Lacy. Lake Montebello, Baltimore, Md.		Nov. 7, 1894
Kennedy, James Henry. Asst. Chf. Engr., Vancouver, Victoria & East. Ry. & Nav. Co., Keremeos, B. C., Canada		May 2, 1900
Kennedy, Jeremiah Joseph. Cons. Engr., 52 Broadway, New York City		June 4, 1902

		Date of Membership.
Kennedy, John. Cons. Engr., Harbor Commrs., 57 Common St., Montreal, Que., Canada		Sept. 1, 1875
Kennedy, William Harlin. 400 Atlantic Ave., Pittsburg, Pa.		Sept. 6, 1871
Kenney, Edward Fulbister. Metallurgical Engr., Cambria Steel Co., Johnstown, Pa	Jun. Assoc. M. M.	Nov. 3, 1896 May 3, 1899 April 3, 1906
Kenrick, Robert Boteler. Care, Dominion Bridge Co., Montreal, Que., Canada		July 9, 1906
Kent, Willard. Narragansett Pier, R. I		Oct. 2, 1907
Kernot, Maurice Edwin. Chf. Engr. for Railway Constr., Victorian Railways, Railway Dept., Spencer St., Melbourne, Victoria, Australia		June 5, 1907
Kerr, Frank Montgomery. Chf. State Engr. of Louisiana, 402 Cotton Exchange Bldg., New Orleans, La		Oct. 2, 1901
Kerr, Halbert Stevens. Gen. Mgr., Jalapa R. R. & Power Co., Jalapa, Ver., Mexico		Feb. 5, 1908
Kerr, Luther Yager. U. S. Engr. Office, Custom House, Memphis, Tenn		June 4, 1902
Ketchum, Milo Smith. (Crocker & Ketchum, Cons. Engrs.), 811 Seventeenth St., Suite 438, Denver, Colo	Assoc. M. M.	Sept. 4, 1901 Mar. 3, 1908
Ketchum, Richard Bird. Assoc. Prof. of Civ. Eng., Univ. of Utah, Salt Lake City, Utah		June 5, 1907
Khuen, Richard. Res. Engr., Am. Bridge Co., Pittsburg, Pa	Jun. Assoc. M. M.	Dec. 3, 1891 May 1, 1895 Nov. 2, 1898
Kibbe, Augustus Sayre. Chf. Engr., The Am. Rys. Co., 906 Witherspoon Bldg., Philadelphia, Pa	Jun. M.	Mar. 6, 1889 Aug. 31, 1909
Kieffer, Stephen Ephraim. Civ. and Hydr. Engr., First National Bank Bldg., Berkeley, Cal	Assoc. M. M.	Oct. 5, 1904 Jan. 3, 1907
Kielland, Soren Theodor Munch Bull. Civ. Engr., Buffalo Creek R. R.; V. Consul of Norway; 364 Ellicott Sq., Buffalo, N. Y		Feb. 6, 1889
Kiersted, Wynkoop. Cons. Engr., 58 Water-Works Bldg., Kansas City, Mo		Oct. 5, 1887
Kimball, Frank Clifton. 14 Beacon St., Boston, Mass		June 3, 1903
KIMBALL, GEORGE ALBERT. (*Director*). Chf. Engr., Elev. Subway Constr., Boston Elev. Ry., 101 Milk St., Boston, Mass	Jun. M.	May 12, 1875 July 1, 1891
Kimball, George Henry. Cons. Engr., 309 Union Trust Bldg., Detroit, Mich		Dec. 3, 1890
King, Charles Cyrus. Chf. Engr., C. W. Hunt Co., West New Brighton, Richmond Co., N. Y		Sept. 2, 1891
King, Paul Sourin. Cons. Engr., 3034 North 15th St., Philadelphia, Pa		July 3, 1889

		Date of Membership.
King, William Byrd. Gen. Mgr., Fort Worth Stock Yards Co. and Fort Worth Belt Ry. Co., Fort Worth, Tex.		Oct. 7, 1896
King, Winfield Scott. 2311 G St., South Omaha, Nebr.		Dec. 6, 1899
Kingman, Lewis. Asst. Chf. Engr., National Lines of Mexico (Res., 1-A Liverpool No. 3), City of Mexico, Mexico.		July 1, 1885
Kingsley, Marvin Watson. Civ. and Hydr. Engr., 823 Rose Bldg., Cleveland, Ohio		July 3, 1878
Kinnear, Wilson Sherman. Asst. Gen. Mgr., Mich. Cent. R. R. Co., Detroit, Mich.		July 9, 1906
Kinsley, Thomas Pearson. New Paltz, N. Y.		Feb. 5, 1873
Kirkpatrick, Walter Gill. Cons. Municipal and Hydr. Engr., Jackson, Miss.	Assoc. M. M.	April 6, 1892 Oct. 5, 1898
KITTREDGE, GEORGE WATSON. (*Director*). Chf. Engr., N. Y. C. & H. R. R. R., N. J. Shore Line R. R., Terminal Ry. of Buffalo, 335 Madison Ave., New York City		Jan. 6, 1886
Kittrell, James Wesson. Catskill, N. Y.		Sept. 1, 1897
Klapp, Eugene. Cons. Engr. (Wm. Barclay Parsons), 60 Wall St., New York City		Feb. 6, 1901
Kleinbeck, August Gustave. Litchfield, Ill.		Feb. 3, 1897
Klinck, John Henry. 123 N. Negley Ave., Pittsburg, Pa.		June 3, 1908
Kluegel, Charles Henry. Chf. Engr., Hilo R. R. Co., Hilo, Hawaii		Oct. 1, 1902
KNAP, JOSEPH MOSS. (*Treasurer*). 220 West 57th St., New York City		April 5, 1882
Knapp, Hermann Meriwether. Contr. Mgr., Am. Bridge Co. of N. Y., Union Trust Bldg., Cincinnati, Ohio	Assoc. M. M.	May 6, 1903 Jan. 31, 1905
Knapp, Louis Henry. Civ. and Hydr. Engr., 280 Linwood Ave., Buffalo, N. Y.		Mar. 4, 1874
Knapp, Zac Ellis. Asst. Engr., Underground Elec. Railways Co. of London, Ltd., Elec. Railway House, Broadway, Westminster, London, S. W., England		Dec. 5, 1906
Knickerbacker, John. Pres., Eddy Valve Co., Waterford, N. Y.		Jan. 2, 1900
Knickerbocker, Curtis Edwin. Engr., M. of W., N. Y., O. & W. Ry. Co., Middletown, N. Y.		Feb. 1, 1905
Knight, Charles William. Rome, N. Y.		July 9, 1906
Knight, Richard Warren. Contr. Engr., McClintic-Marshall Constr. Co., Park Bldg., Pittsburg, Pa.		Feb. 2, 1909
Knight, Walter Harris. Care, International Power Co., 165 Broadway, New York City		Feb. 1, 1893
Knighton, John Albert. Asst. Engr., Dept. of Bridges, New York City; Engr. in Chg., Queensboro Bridge, 56 Sutton Pl., New York City		Jan. 4, 1905
Knobloch, Walstan Emile. U. S. Asst. Engr., 3338 St. Charles Ave., New Orleans, La.		Oct. 2, 1907

		Date of Membership.
Knowles, Morris. Chf. Engr., Bureau of Filtration, City Hall, Pittsburg, Pa.	Jun. Assoc. M. M.	Oct. 4, 1892 Jan. 1, 1896 April 1, 1903
Knowlton, Theodore Ely. Cons. Engr., 167 Clinton St., Watertown, N. Y.	Assoc. Assoc. M. M.	Mar. 31, 1896 May 7, 1902 Sept. 1, 1908
Knox, Samuel Lippincott Griswold. Vice-Pres. and Chf. Engr., The Bucyrus Co., South Milwaukee, Wis.		July 10, 1907
Knox, Schuyler Brush. Eastern Mgr. and Contr. Engr., Fort Pitt Bridge Works, 45 Broadway, New York City		Nov. 8, 1909
Kondo, Sentaro. Doboku Shitchojo, Naimusho, Tokyo, Japan		Nov. 7, 1900
Kondo, Toragoro. Chf. Engr., Home Dept., Tokyo, Japan	Jun. M.	Oct. 3, 1888 June 5, 1901
Kops, Julian de Bruyn. Civ. Engr. and Archt., 27 Bay St., East, Savannah, Ga.	Assoc. M. M.	April 4, 1894 Jan. 5, 1904
Kower, Hermann. East Hall, Univ. of California, Berkeley, Cal.		Oct. 5, 1904
Kroeber, Adolf Thomas. Govt. Engr., Buiko, *via* Tanga, German East Africa		Oct. 2, 1907
Kuersteiner, Emil Edward. Bridge Engr., L. & N. R. R., 1274 South Floyd St., Louisville, Ky.		Dec. 1, 1897
Kuichling, Emil. Cons. Engr., 52 Broadway, New York City		Sept. 3, 1884
Kummer, Frederic Arnold. Cons. Engr., 26 South St., Baltimore, Md.	Jun. Assoc. M. M.	April 30, 1895 Mar. 4, 1903 Oct. 2, 1906
Kunz, Frederic Charles. Cons. Engr., Osborne and Vicaris Sts., Wissahickon, Philadelphia, Pa.	Assoc. M. M.	Feb. 6, 1895 Dec. 7, 1898
Kutz, Charles Willauer. Maj., Corps of Engrs., U. S. A., P. O. Box 1809, Seattle, Wash.		May 7, 1902
Kwong, King Yang. Engr.-in-Chf., Yueh Han Ry. Co., Ltd., Canton, China		April 1, 1908

Labelle, Henry Francis. Cons. Hydr. Engr., Silver City, N. Mex.		April 6, 1898
La Chicotte, Henry Arthur. Engr. in Chg., Manhattan Bridge (No. 3), and Blackwell's Island Bridge (No. 4), Dept. of Bridges, New York City		Oct. 3, 1894
Lackey, Oscar Francis. Harbor Engr., Baltimore, Md.	Assoc. M. M.	May 4, 1904 April 6, 1909
LaForge, Frederick William. U. S. Asst. Engr., Care, U. S. Engr. Office, New London, Conn.		Oct. 5, 1904
Lahmer, John Aloysius. Prin. Asst. Engr., The Kansas City Southern Ry. Co., Kansas City, Mo.		June 3, 1908
Lake, Edward Nelson. Div. Engr., Board of Superv. Engrs., 181 La Salle St., Chicago, Ill.		July 1, 1909

Member	Grade	Date of Membership.
Lall, Chiranji. Head Master, Govt. School of Eng., Anarkali, Nila Gumbad Mool Chand New Bldg., Lahore, Punjab, India		Oct. 5, 1909
Lamb, Richard. Cons. and Const. Engr., 136 Liberty St., Room 528, New York City	Assoc. M. M.	May 6, 1891 June 6, 1900
Landon, Eugene Ashbel. Secy. and Treas., Begent Lumber Co., Groton, N. Y.		April 1, 1896
Landor, Edward John. Contr. Engr., 1013 N. Walnut St., Canton, Ohio		Mar. 7, 1888
Landreth, Olin Henry. Prof. of Eng., Union Coll.; Cons. Engr., Schenectady, N. Y.		Sept. 3, 1884
Landreth, William Barker. Special Deputy State Engr., Albany, N. Y.		Oct. 3, 1888
Lang, Otto Heinrich. Archt. and Structural Engr. (Lang & Witchell), 622 Wilson Bldg., Dallas, Tex.		Oct. 5, 1904
Lange, Gunardo Anfin. Colonia Alvear, Prov. de Mendoza, Argentine Republic		Mar. 3, 1897
Langthorn, Jacob Stinman. Div. Engr., Reservoir Dept., Board of Water Supply, City of New York, Brown Station, N. Y.		Jan. 4, 1905
Langton, John. Cons. Engr., 31 Nassau St., New York City		May 2, 1900
Lant, Frank Parsons. Mgr., Lawyers Eng. & Surv. Co., 135 Broadway, New York City	Jun. M.	Oct. 3, 1888 Feb. 1, 1910
Larrabee, William Dominick. Civ. and Cons. Engr., 708 Grosse Bldg., Los Angeles, Cal.		Oct. 5, 1904
Larsson, Carl Gustaf Emil. Asst. Chf. Engr., Am. Bridge Co. of N. Y., 9 Rockview Terrace, Plainfield, N. J.		April 1, 1903
Latey, Harry Nelson. Cons. Engr., 100 Broadway, New York City		June 6, 1906
Lathbury, Benjamin Brentnall. Cons. Engr., Land Title Bldg., Philadelphia, Pa.	Assoc. M. M.	Mar. 3, 1897 June 6, 1905
Latta, Harrison Wainwright. Pres., Latta & Terry Constr. Co., 1319 Pennsylvania Bldg., Philadelphia, Pa.	Assoc. M. M.	Sept. 5, 1900 April 4, 1905
Laub, Hermann. 610 Lewis Blk., Pittsburg, Pa.		Sept. 1, 1897
Lavis, Fred. Cons. Engr. (Guerber, Lavis & Co.), 50 Church St., New York City	Assoc. M. M.	Sept. 6, 1899 Sept. 4, 1906
Lawlor, Francis Denis Hubert. Citizens Water Co., Burlington, Iowa	Jun. M.	Oct. 6, 1886 Mar. 6, 1895
Lawrence, Edgar Heisler. Structural Engr., Nimmons & Fellows, Archts., 1733 Marquette Bldg., Chicago, Ill.		Oct. 5, 1909
Lawson, Thomas R. William Howard Hart Prof. of Rational and Technical Mechanics, Rens. Poly. Inst., 99 Twelfth St., Troy, N. Y.	Assoc. M. M.	June 3, 1903 Jan. 3, 1907
Lawton, William Henry. City Engr., 24 Bellevue Ave., Newport, R. I.		June 2, 1886

		Date of Membership.
Layfield, Elwood Norman. Chf. Engr., Chic. Terminal Transfer R. R. Co., 353 Grand Central Passenger Station, Chicago, Ill		June 5, 1907
Layton, Hudson Flack. Civ. and Cons. Engr., 413 Fourth Ave., Pittsburg, Pa		Nov. 30, 1909
Lea, Allan Benjamin. Araoz 2854, Palermo, Buenos Aires, Argentine Republic		Mar. 4, 1908
Lea, Richard Smith. 405 Dorchester St., West., Montreal, Que., Canada		July 1, 1908
Lea, Samuel Hill. State Engr. of South Dakota; Superv. Engr., State Capitol, Pierre, S. Dak		Nov. 3, 1897
Lea, Sumter, Jr. Room 522, Empire Bldg., Birmingham, Ala.		Mar. 4, 1908
Leavenworth, George Stevens. Chf. Engr., Powers & Mansfield Co., 297 River St., Troy, N. Y.	Assoc. M. M.	June 3, 1903 Feb. 5, 1907
Leavitt, Charles Wellford, Jr. Civ. and Landscape Engr., 220 Broadway, New York City.	Assoc. M. M.	Jan. 4, 1898 May 2, 1905
Leavitt, Erasmus Darwin. 33 Garden St., Cambridge, Mass..		July 2, 1873
Leavitt, Frank McDowell. Cons. Engr. to E. W. Bliss Co., 133 Plymouth St., Brooklyn, N. Y		Dec. 2, 1885
Le Baron, John Francis. Cons. Engr., Chardon, Ohio		June 7, 1882
Le Conte, Louis Julian. U. S. Asst. Engr. in Chg., Oakland Harbor Works, P. O. Box 482, Oakland, Cal		April 4, 1877
Ledlie, Charles Hees. Cons. Engr., 918 Rialto Bldg., St. Louis, Mo		Jan. 4, 1888
Ledoux, John Walter. Chf. Engr., The Am. Pipe Mfg. Co., 112 North Broad St., Philadelphia, Pa		June 5, 1895
Lee, Edward Hervey. Chf. Engr., Chic. & W. Indiana R. R. and The Belt Ry. of Chicago, Room 45, Dearborn Station, Chicago, Ill		June 6, 1900
Lee, Wellington Barnes. Hillburn, N. Y	Assoc. M. M.	Feb. 5, 1896 May 4, 1898
Lee, William States. Chf. Engr., Southern Power Co., Charlotte, N. C		Oct. 4, 1905
Leffingwell, Frank Dodge. 467 Bloomfield Ave., Montclair (Res., 716 Valley Rd., Upper Montclair), N. J	Assoc. M. M.	Oct. 5, 1898 Dec. 5, 1905
Leffingwell, William Howland. Chf. Engr., Mono Power Co., Bishop, Inyo Co., Cal		Oct. 4, 1893
Legaré, Balie Peyton. Engr., M. of W. and Constr., United Railroads of San Francisco, San Francisco, Cal		July 10, 1907
Lehlbach, Gustav. 196 Market St., Newark, N. J		Mar. 7, 1883
Lehnartz, Frederick William. U. S. Asst. Engr., U. S. Engr. Office, Grand Rapids, Mich		Aug. 6, 1879
Leighton, George. Res. Engr., D., L. & W. R. R. Co., Andover, N. J		Oct. 3, 1906

			Date of Membership.
	Leisen, Theodore Alfred. Cons. Engr.; Chf. Engr. and Supt., Louisville Water Co., Louisville, Ky.		June 2, 1897
	Leland, George Herbert. 930 Banigan Bldg., Providence, R. I.	Jun. M.	Mar. 2, 1887 Feb. 1, 1893
	Leland, Warren Allston. Chf. Engr. and Res. Mgr., Federal Constr. Co., Rockingham, N. C.		Oct. 3, 1900
	Lentilhon, Eugene. Cons. Engr., 37 West 44th St., New York City	Jun. Assoc. M. M.	Mar. 1, 1891 Mar. 5, 1895 Feb. 6, 1906
	Leonard, Henry Read. Engr. of Bridges and Bldgs., P. R. R. Co., Broad St. Station, Philadelphia, Pa.		April 4, 1894
	Leonard, James Augustus. Care, Bangor Ry. & Elec. Co., Veazie, Me.		April 1, 1908
	Leonard, John Buck. Structural Engr., 813 Sheldon Bldg., San Francisco, Cal.		June 1, 1909
	Lepper, Fred William. Supt. of Constr. of Public Bldgs., 504 Chamber of Commerce Bldg., Cleveland, Ohio	Assoc. M. M.	Jan. 2, 1901 Feb. 6, 1906
	Lewerenz, Alfred Courtney. Civ. Engr., U. S. N., Naval Station, Honolulu, Hawaii	Jun. Assoc. M. M.	Mar. 5, 1895 June 6, 1900 Mar. 6, 1906
	Lewinson, Maxymilian. 128 West 42d St., New York City		Feb. 7, 1894
	Lewis, Clarence Charles. Mgr., Cordoba Office, J. G. White & Co., Ltd., Cordoba, Argentine Republic		Feb. 6, 1907
	Lewis, Eugene Castner. Chairman, Board of Directors, N., C. & S. L. Ry.; Pres. of The American Co., Nashville, Tenn.		Mar. 5, 1873
	Lewis, Everett Wilson. Locating Engr., N. Y., N. H. & H. R. R., New Haven, Conn.		Sept. 4, 1901
	Lewis, Frederick Humphreville. Vice-Pres. and Gen. Mgr., Standard Portland Cement Co., Leeds, Ala.		Jan. 6, 1897
	Lewis, Marcus Winfield. U. S. Junior Engr., 300 West 4th St., Superior, Wis.		June 5, 1907
	Lewis, Nelson Peter. Chf. Engr., Board of Estimate and Apportionment, 277 Broadway, New York City		Oct. 2, 1895
	Lewis, Sidney Francis. Chf. Engr., Orleans Levee Board, 15 Masonic Temple, New Orleans, La.		May 4, 1881
	Lieb, John William, Jr. Third Vice-Pres. and Assoc. Gen. Mgr., The New York Edison Co., 55 Duane St., New York City		May 5, 1898
	Lilly, George Washington. Chf. Engr., St. Helens Public Service Co., 606 Marquam Bldg., Portland, Ore.	Assoc. M. M.	April 2, 1902 Jan. 31, 1905
R.	Lindenthal, Gustav. Cons. Engr., 45 Cedar St., New York City		May 3, 1882
	Lindsey, John Brown, Jr. Supt., West Pascagoula Creosoting Works, Gautier, Jackson Co., Miss.	Assoc. M. M.	June 3, 1903 Oct. 5, 1909

		Date of Membership.
Linton, Harvey. Civ. and Cons. Engr., 1717 Thirteenth St., Altoona, Pa		Oct. 5, 1892
Lippincott, Joseph Barlow. Asst. Chf. Engr., Los Angeles Aqueduct, 1108 Central Bldg., Los Angeles, Cal		Dec. 6, 1899
Lipsey, Thomas Eugene Leard. Asst. Engr., Dept. of Constr. and Eng., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Assoc. M. M.	April 6, 1904 Oct. 2, 1906
List, Charles. 211 Williams Bldg., San Francisco, Cal		June 3, 1903
Livingston, Archibald Rogers. Supt., The Empire Zinc Co., Cañon City, Colo		April 3, 1907
Llewellyn, Francis John. Div. Contr. Mgr., Am. Bridge Co. of N. Y., 1316 Commercial National Bank Bldg., Chicago, Ill		Nov. 4, 1896
Llewellyn, Frederick Thomas. With Carnegie Steel Co., 30 Church St., New York City	Assoc. M. M.	Oct. 4, 1899 May 1, 1906
Locke, Charles Abbott. 1805 Belmont Circle, Nashville, Tenn.		Oct. 3, 1888
Locke, Franklin Buchanan. Commr. of Public Works, North Adams, Mass		Mar. 1, 1893
Lockwood, James Button Clyde. Cons. Engr., 1010 Board of Trade Bldg., Portland, Ore		Mar. 6, 1901
Lockwood, Judd Allen. Asst. Engr., Dept. of Bridges, 63 West 135th St., New York City		April 4, 1899
Lockwood, Willard Datus. Rockville Center, N. Y	Jun. Assoc. M. M.	April 3, 1894 Oct. 7, 1896 Oct. 2, 1906
Lofland, Henry Fiddeman. Gen. Mgr. of Erection, Am. Bridge Co. of N. Y., 15th and Chestnut Sts., Philadelphia, Pa		June 2, 1897
Long, Maurice Alvin. Archt., B. & O. R. R., B. & O. R. R. Bldg., Baltimore, Md		Oct. 5, 1909
Look, Moses Jerome. Gen. Supt., MacArthur Bros. Co. and Winston & Co., Contrs., Brown Station, N. Y	Assoc. M. M.	May 6, 1903 April 4, 1905
LOOMIS, HORACE. (*Director*). Chf. Engr. of Sewers, Borough of Manhattan, 13 Park Row, New York City		Nov. 5, 1879
Loomis, Thomas Hooker. Cons. and Contr. Engr., Steubenville, Ohio		Jan. 7, 1903
Loree, Leonor Fresnel. Care, Hoffman House, New York City		Oct. 6, 1886
Lorraine, Madison Johnson. 2107 Dwight Way, Berkeley, Cal.		Nov. 8, 1909
Lovell, Frederick William. Vice-Pres. and Chf. Engr., The McMyler Mfg. Co. (Res., 10008 Lamont Ave.), Cleveland, Ohio		June 6, 1906
Lovell, Walter Danville. Cons. Engr., 1415 Eighth St., S. E., Minneapolis, Minn.		May 4, 1904
Low, Emile. U. S. Asst. Engr., 540 Federal Bldg. (Res., 606 Ashland Ave.), Buffalo, N. Y		May 2, 1888

		Date of Membership.
Lowe, Jesse. (Christie & Lowe, Civ. Engrs. and Contrs.), 171 La Salle St., Chicago, Ill.		Oct. 2, 1895
LOWETH, CHARLES FREDERICK. (*Director*). Engr. and Supt., Bridges and Bldgs., C., M. & St. P. Ry. and C. M. & P. S. Ry. Cos., Room 1359 Railway Exchange, Chicago, Ill.	Jun. M.	Jan. 3, 1883 Feb. 6, 1884
Lowrie, Harvey Childs. 1107 Flatiron Bldg., New York City.		Mar. 2, 1892
Lucas, Daniel Jones. Dept. of Public Works, Bureau of Surveys, Grade Crossing Div., Asst. Engr. in Chg. of Field Office, 2603 N. Broad St., Philadelphia, Pa.	Jun. M.	Sept. 6, 1876 July 4, 1888
Lucas, Eugene Willett Van Court. Gen. Mgr., Eng. Dept. and Member of Firm of Hugh MacRae & Co., Wilmington, N. C.	Assoc. M. M.	April 3, 1895 Sept. 5, 1900
Lucius, Albert. 38 Park Row, Room 607, New York City.		Mar. 3, 1886
Ludlow, Jacob Lott. Cons., Municipal, San. and Hydr. Engr., Winston-Salem, N. C.		Mar. 3, 1897
Luiggi, Luigi. Insp. Gen., Royal Civ. Engrs.; Prof. of Maritime Constructions at the Royal School of Civ. Engrs., 81 Via Sardegna, Rome, Italy.		Feb. 7, 1906
Lum, David Walker. Chf. Engr., M. of W. and Structures, Southern Ry., Washington, D. C.		May 3, 1893
Lundie, John. Cons. Engr., 52 Broadway, New York City.		July 4, 1888
Lupfer, Alexander McClure. Chf. Engr., Spokane & Inland Empire R. R. Co., Terminal Bldg., Spokane, Wash.		Nov. 1, 1905
Lupfer, Edward Payson. 590 Ellicott Sq., Buffalo, N. Y.		Jan. 3, 1906
Luster, William Henry, Jr. City Surv., City Hall, Elizabeth, N. J.	Assoc. M. M.	Oct. 3, 1900 April 2, 1902
Lydon, William Anthony. Pres., Great Lakes Dredge & Dock Co., Chamber of Commerce, Chicago, Ill.	Jun. M.	Jan. 4, 1888 Dec. 5, 1894
Lyford, Oliver Smith, Jr. Cons. Elec. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City.		May 6, 1908
Lynch, Michael Lehane. Chf. Engr., St. Louis S. W. Ry. System, Tyler, Tex.		May 4, 1892
Lyon, Henry Lloyd. Deputy Water Commr., Municipal Bldg., Buffalo, N. Y.		Feb. 3, 1904
Lyon, Léon Élie. Asst. U. S. Engr., U. S. Engr. Office, Norfolk, Va.	Jun. Assoc. M. M.	Feb. 1, 1898 April 4, 1900 June 5, 1906
Lyons, James Knox. Pres., Gas Power Eng. Corporation, Empire Bldg. (Res., 5820 Baum St., E. E.), Pittsburg, Pa.	Assoc. M. M.	May 1, 1895 Oct. 5, 1898
MacAllister, Dickinson. Fort Hunter P. O., Pa.		April 1, 1896
MACDONALD, CHARLES. (*Past-President*). 5 Nassau St., New York City.		Sept. 15, 1869

		Date of Membership.
MacHarg, William Storrs. Cons. Engr., Bureau of Eng., Dept. of Public Works, Room 806, City Hall, Chicago, Ill.		Dec. 2, 1903
Machen, Henry Bennett. Asst. Engr., Dept., Water Supply (Res., 315 West 97th St.), New York City	Jun. Assoc. M. M.	May 2, 1899 Feb. 1, 1905 April 6, 1909
Mackall, Benjamin Franklin. 206 Met. Bank Bldg., Washington, D. C.		Mar. 6, 1901
MacKay, Henry Martyn. Prof. of Civ. Eng., McGill Univ., Montreal, Que., Canada		July 10, 1907
Mackenzie, Alexander. Retired Chf. of Engrs. and Maj.-Gen., U. S. A., The Birmingham, 2811 Adams Mill Rd., Washington, D. C.	M. Hon. M.	Feb. 2, 1887 May 12, 1905
Macksey, Henry Vincent. 15 Court Sq., Boston, Mass.		May 4, 1904
Maclay, William Walter. Cons. Engr., Lee, Mass.		Nov. 6, 1872
McCalla, William Augustus. City Engr., Decatur and New Decatur; Address, Decatur, Ala.		Nov. 30, 1909
McCann, Thomas Henry. Chf. Engr., Hoboken Mfrs. R. R. Co., Second National Bank Bldg., Hoboken, N. J.		April 2, 1890
McCarthy, George Arnold. Care, Smith, Kerry & Chace, 68 McDougall Blk., Calgary, Alta., Canada		Nov. 6, 1907
McCarty, Richard Justin. 3820 Warwick Boulevard, Kansas City, Mo.		Dec. 4, 1895
McCaustland, Elmer James. Prof. of Civ. Eng., Univ. of Washington; San. Engr., State Board of Health, 5264 Nineteenth Ave., N. E., Seattle, Wash.	Assoc. M. M.	Sept. 5, 1900 June 6, 1905
McClintock, J. Y. County Engr. of Monroe County, Rochester, N. Y.		Oct. 2, 1895
McClintock, William Edward. Chairman, Board of Control, 27 Crescent Ave., Chelsea, Mass.		Dec. 5, 1888
McCollom, Thomas Chalmers. Civ. Engr., U. S. N. (*Retired*), 4606 Springfield Ave., Philadelphia, Pa.		May 3, 1882
McComb, Charles Oscar. Engr. and Contr., 403 University Bldg., Syracuse, N. Y.		May 2, 1900
McComb, David E. Chf. Engr., Pavement and Sewerage Work, Havana, Cuba		Feb. 7, 1877
McConnel, Wilfred Gillette. Chf. Engr., Rio de Janeiro Tramway Light & Power Co., Ltd., Rio de Janeiro, Brazil.		June 3, 1903
McCool, Daniel. Pres., Newaygo (Mich.) Portland Cement Co.; Pres., Grand Rapids Edison Co., Grand Rapids, Mich.		Sept. 5, 1883
McCormack, Edgar Walter. San Ignacio 82, Havana, Cuba	Assoc. M. M.	Mar. 6, 1901 Dec. 5, 1905
McCormick, George King. Roadmaster, L. & N. R. R. Co., Etowah, Tenn.	Jun. M.	Feb. 6, 1889 May 4, 1898
McCormick, Robert Hugh. City Engr., Detroit, Mich.		Sept. 7, 1898

		Date of Membership.
McCoy, Samuel Alexander. Contr. (Boynton, Church & McCoy), 1618 W. 11th St., Spokane, Wash.	Assoc. M. M.	Sept. 6, 1905 Dec. 4, 1906
McCrickett, Thomas Francis. Care, Russel Wheel & Foundry Co., Detroit, Mich.		Jan. 2, 1907
McCulloch, Robert Austen. Chf. Engr. with R. F. Almirall, 51 Chambers St., New York City	Jun. Assoc. M. M.	Sept. 2, 1902 Sept. 7, 1904 Sept. 3, 1907
McCulloh, Ernest. Project Engr., U. S. Reclamation Service, Sunnyside, Wash.		May 6, 1903
McCulloh, Walter. Cons. Engr., N. Y. State Water Supply Comm., Lyon Blk., Albany, N. Y.	Jun. M.	July 4, 1888 June 7, 1893
McDONALD, HUNTER. (*Vice-President*). Chf. Engr., N. C. & St. L. Ry., 10 Terminal Station, Nashville, Tenn.	Jun. M.	April 4, 1883 Mar. 7, 1888
McDonald, John Alexander. Care, James E. McDonald, 4 Chapel St., Cripple Gate, London, E. C., England		Feb. 5, 1890
McDonald, William Naylor. Gen. Contr., 214 Stahlman Bldg., Nashville, Tenn.		Sept. 3, 1902
McDonnell, Robert Emmett. Civ., Hydr. and San. Engr., Room 804, Scarritt Bldg., Kansas City, Mo.		Oct. 5, 1909
McFetridge, William Sutton. Plum St., Greenville, Pa.	Jun. Assoc. M. M.	May 3, 1898 Mar. 4, 1903 Sept. 3, 1907
McGilvray, Thomas Forrester. Cons. Engr.; City Engr., City Hall, Duluth, Minn.	Assoc. M. M.	Feb. 5, 1902 June 6, 1905
McGrath, Wallace. 910 Tennessee St., Lawrence, Kans.		Sept. 5, 1883
McGrew, Anson Burlingame. U. S. Asst. Engr., Room 2106, Farmers Bank Bldg., Pittsburg, Pa.		June 4, 1902
McHenry, Edwin Harrison. Vice-Pres., N. Y., N. H. & H. R. R., New Haven, Conn.		Feb. 5, 1896
McInnes, Frank Alexander. Asst. City Engr., City of Boston; Address, 23 Salcombe St., Dorchester, Mass.		Jan. 8, 1908
McKay, George Albert. Civ. Engr., U. S. N., U. S. Naval Training Station, Great Lakes, North Chicago, Ill.	Assoc. M. M.	Feb. 4, 1903 Nov. 8, 1909
McKay, Hood. Gen. Mgr., Stone Canon Consolidated Coal Co., Stone Canon, Cal.		Nov. 6, 1907
McKay, John Edwards. 21 Park Row (Res., 55 St. Nicholas Pl.), New York City		July 5, 1893
McKeen, Benjamin. Gen. Mgr., Vandalia R. R., 806 Century Bldg., St. Louis, Mo.		Nov. 6, 1895
McKenney, Charles Albert. Cons. Engr., Hibbs Bldg., Washington, D. C.	Jun. Assoc. M. M.	Dec. 4, 1894 Dec. 1, 1897 Mar. 2, 1909

		Date of Membership.
McKENZIE, THEODORE HALL. Engr., State Board of Health; Member, State Board of Civ. Engrs., State Capitol, Hartford (Res., Southington), Conn		Sept. 7, 1881
McKIBBEN, FRANK PAPE. Prof. of Civ. Eng., Lehigh Univ., South Bethlehem, Pa	Jun. Assoc. M. M.	Jan. 3, 1895 Mar. 6, 1901 Oct. 3, 1905
McKIM, ALEXANDER RICE. Cons. Engr., 116 East 28th St., New York City	Assoc. M. M.	April 4, 1894 May 4, 1898
McKIM, JAMES ARTHUR. Secy.-Treas., Westlake Const. Co., Mercantile Bldg., St. Louis, Mo		Oct. 2, 1901
McKINSTRY, CHARLES HEDGES. Maj., Corps of Engrs., U. S. A., 665 Monadnock Bldg., San Francisco, Cal	Assoc. M. M.	Sept. 2, 1896 May 3, 1899
McLAIN, LOUIS RANDOLPH. Pres., Florida Eng. Co., St. Augustine, Fla		Feb. 2, 1881
McLAUGHLIN, JOHN JOSEPH. County Engr., Queens Co., Jamaica, N. Y		Nov. 1, 1893
McLEAN, ARCHIBALD. Asst. Engr., Dept. of Bridges, City of New York, 179 Washington St., Brooklyn, N. Y		May 6, 1903
McMATH, ROBERT EMMET. Pres., R. E. McMath Surveying Co., 328 Lincoln Trust Bldg., St. Louis, Mo		Mar. 3, 1880
McMILLAN, CHARLES. Prof. of Civ. Eng., Princeton Univ.; Cons. Engr., Princeton, N. J		Jan. 29, 1868
McMILLAN, JOHN GILMORE. County Surv., Santa Clara Co., Hall of Records, San José, Cal		Oct. 5, 1909
McMINN, THOMAS JAMES. (*Assistant Secretary*). 220 West 57th St., New York City (Res., 622 Ave. K, Flatbush, Brooklyn, N. Y.)		Mar. 5, 1890
McMORRIS, DANIEL WEBSTER. Prin. Asst. City Engr., Seattle, Wash.		May 2, 1906
McMURTRY, GUY. Yuba City, Cal		Mar. 2, 1909
McNAB, WILLIAM. Prin. Asst. Engr., Grand Trunk Ry. System, Montreal, Que., Canada		Dec. 1, 1908
McNAUGHER, DAVID WHITE. (Robert W. Hunt & Co.), Monongahela Bank Bldg., Pittsburg, Pa		June 3, 1908
McNEAL, JOHN. City Engr. and Commr. of Highways, Easton, Pa.		Dec. 2, 1903
McNICOL, JOHN ALEXANDER. Box 733, Havana, Cuba		Sept. 1, 1897
McNULTY, GEORGE WASHINGTON. 153 West 79th St., New York City		May 5, 1880
McREYNOLDS, ORVAL OMAR. Cons. Civ. and Min. Engr., 318 H. W. Hellman Bldg., Los Angeles, Cal	Assoc. M. M.	Dec. 5, 1900 Mar. 5, 1907
McVEAN, JOHN JAY. Cons. Engr., 444 Houseman Bldg., Grand Rapids, Mich		Sept. 3, 1884
MAIN, CHARLES THOMAS. 201 Devonshire St., Boston, Mass		July 1, 1909

		Date of Membership.
MAIS, HENRY COATHUPE. Cons. Engr., 34 Murphy St., South Yarra, near Melbourne, Victoria, Australia		June 6, 1883
MAITLAND, ALEXANDER, JR. 4104 Harrison St., Kansas City, Mo		Nov. 6, 1901
MALMROS, NILS LORENTZ. Care, Ernest Flagg, 35 Wall St., New York City		Feb. 1, 1910
MALONEY, JAMES EDWARD. Supt., River Div., Denver Union Water Co., Littleton, Colo		Oct. 7, 1908
MALTBY, FRANK BIERCE. Chf. Engr., Dodge & Day, 608 Chestnut St., Philadelphia, Pa		April 3, 1895
MAN, ALBON PLATT. 56 Wall St., New York City		Sept. 5, 1883
MANAHAN, ELMER GOVE. With Hering & Fuller, 170 Broadway, New York City	Assoc. M. M.	Oct. 7, 1903 Feb. 2, 1909
MANLEY, HENRY. Asst. Engr., Eng. Dept., Boston, Mass		June 2, 1880
MANLEY, LAURENCE BRADFORD. 22 Garden St., West Roxbury, Mass		July 1, 1909
MANNING, ROLLO GLENROY. Engr., Ambridge Plant, Am. Bridge Co., Ambridge, Pa	Assoc. M. M.	Oct. 2, 1901 Oct. 30, 1906
MANSON, MARSDEN. City Engr., 2010 Gough St., San Francisco, Cal		Sept. 6, 1882
MARBURG, EDGAR. Prof. of Civ. Eng., Univ. of Pennsylvania, Philadelphia, Pa		Oct. 6, 1897
MARDEN, HENRY HERMAN, JR. Care, The United Eng. & Contr. Co., 17 West 42d St., New York City		May 1, 1901
MARDEN, WALTER REUBEN. Vice-Pres. and Chf. Engr., The United Constr. Co., 467 Broadway, Albany, N. Y	Assoc. M. M.	April 4, 1894 Feb. 28, 1905
MARPLE, WILLIAM MCKELVEY. Chf. Engr., The Scranton Gas & Water Co., Dunmore Gas & Water Co., Olyphant Water Co., Archbald Water Co. and Consolidated Water Supply Co., Scranton, Pa		June 4, 1890
MARR, WILLIAM WALTER. 1833 Eddy St., Chicago, Ill		Feb. 2, 1909
MARROQUIN Y RIVERA, MANUEL. 3a Calle Manuel Ma Contreras No. 38, City of Mexico, D. F., Mexico		June 5, 1907
MARSH, CHARLES FLEMING. Chf. Asst. Engr., Met. Water Board, Savoy Court, London, England		Oct. 3, 1906
MARSH, JAMES BARNEY. Pres. and Chf. Engr., The Marsh Bridge Co., Des Moines, Iowa		May 3, 1905
MARSHALL, HORACE MILLER. U. S. Asst. Engr., Vicksburg, Miss		Dec. 3, 1890
MARSHALL, ROBERT ALBERTSEN. Structural Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City		April 1, 1908
MARSHALL, ROBERT BRADFORD. Chf. Geographer, U. S. Geological Survey, Washington, D. C		May 4, 1904

		Date of Membership.
Marston, Anson. Dean of Div. of Eng., Iowa State Coll.; Cons. Engr., Ames, Iowa	Assoc. M. M.	Oct. 4, 1893 Oct. 7, 1903
Marstrand, Otto Julius. 5 Lloyds Ave., London, E. C., England		May 7, 1890
Martin, Edgar Darwin. 172 Washington St., Chicago, Ill.		July 1, 1909
Martin, Kingsley Leverich. Commr. of Bridges, City of New York, Park Row Bldg., New York City	Jun. Assoc. M. M.	Nov. 5, 1895 May 3, 1899 Dec. 1, 1903
Martin, William. 36 Sprague Ave., Bellevue, Pa.		Jan. 7, 1903
Martin, Wisner. 50 Highland Ave., Cambridge, Mass.	Jun. Assoc. M. M.	May 3, 1892 July 3, 1895 May 1, 1901
Marvin, Frank Olin. Dean and Prof. of Civ. Eng., School of Eng., Univ. of Kansas, Lawrence, Kans.		May 5, 1897
Marx, Charles David. Prof. of Civ. Eng., Leland Stanford, Jr., Univ.; Cons. Engr., Stanford University, Santa Clara Co., Cal.		Oct. 7, 1896
Mason, Arthur John. (Hoover & Mason), Railway Exchange, Chicago, Ill.		Sept. 5, 1888
Mason, Francis. 99 Rockview Ave., Plainfield, N. J.	Jun. Assoc. M. M.	April 3, 1900 April 1, 1903 July 1, 1909
Mason, George Cotner. Engr. and Contr., Board of Trade Bldg., Portland, Ore.	Jun. Assoc. M. M.	Mar. 6, 1894 May 3, 1899 Sept. 1, 1908
Mason, Sampson Douglas. Asst. Engr., U. S. Fortification Work, Fort Casey, Wash.		Oct. 6, 1886
Matamoros, Luis. Gen. Director of Public Works of Costa Rica; Chf. Engr. of Constr., Costa Rica Pacific Ry., P. O. Box 295, San José, Costa Rica		Oct. 4, 1905
Matcham, Charles Arthur. Vice-Pres. and Gen. Mgr., Allentown Portland Cement Co., Allentown, Pa.		June 5, 1901
Mather, Thomas Hoggan. Chf. Engr., Syracuse R. R. Constr. Co., Onondaga County Savings Bank Bldg., Syracuse, N. Y.		Oct. 1, 1902
Mathewson, Isaac. Hacendado, Santa Fé, Guerrero, Mexico	Assoc. M. M.	Mar. 7, 1894 Mar. 1, 1904
Mathewson, Thomas Knight. Chf. Engr., Michoacán Power Co., Villaseñor, Guanajuato, Mexico		May 1, 1907
Matthes, Gerard Hendrik. Hydr. Engr., The Central Colorado Power Co., Denver, Colo.	Assoc. M. M.	June 6, 1900 Jan. 31, 1905
Maurice, Charles Stewart. Athens, Pa.		May 15, 1872
Maurice, George Holbrooke. Prin. Asst. Engr., Board of Public Works, 27 South 2d St., Harrisburg, Pa.		Jan. 4, 1910
Maury, Dabney Herndon. Cons. Engr., 129 North Jefferson Ave., Peoria, Ill.		May 3, 1899

		Date of Membership.
MAXIM, *Sir* HIRAM STEVENS. Ryecotes, Dulwich Common, London, S. E., England		Oct. 7, 1885
MAXIMOFF, SERGIUS PAVLOVITCH. Engr. to the Imperial Russian Govt.; Asst. at the Imperial Inst. of Public Ways at St. Petersburg, Zabalkanski pr. 21, St. Petersburg, Russia	Assoc. M. M.	April 1, 1903 Sept. 1, 1908
MAXSON, FRANK OSCAR. Civ. Engr., U. S. N., U. S. Naval Station, Key West, Fla		May 1, 1889
MAXWELL, JAMES RIDDLE. Cons. Engr., Newark, Del		April 17, 1872
MAY, DECOURCY. Pres., New York Shipbuilding Co., Camden, N. J		Mar. 6, 1895
MAY, WILLIAM ANDREW. Gen. Mgr., Hillside Coal & Iron Co., Box 553, Scranton, Pa		July 6, 1881
MAYER, JOSEPH. Prin. Asst. Engr., Quebec Bridge Comm., Canadian Express Bldg., Montreal, Que., Canada		Oct. 3, 1894
MEAD, CHARLES ADRIANCE. Engr. of Bridges, Board of Railroad Commrs., State of New Jersey, Trenton, N. J.; Address, 165 Wildwood Ave., Upper Montclair, N. J	Assoc. M. M.	April 5, 1899 Jan. 5, 1904
MEAD, DANIEL WEBSTER. Prof., Hydr. and San. Eng., Univ. of Wisconsin; Cons. Engr., 401 State St., Madison, Wis	Assoc. M. M.	July 1, 1891 Dec. 6, 1893
MEAD, ELWOOD. Chairman, State Rivers and Water Supply Comm.; Chf. Engr., Water Supply Dept., Melbourne, Victoria, Australia		June 7, 1893
MEANS, THOMAS HERBERT. Project Engr., U. S. Reclamation Service, Fallon, Nev	Assoc. M. M.	July 10, 1907 Oct. 5, 1909
MEBUS, CHARLES FILLMORE. (Albright & Mebus), 908 Land Title Bldg., Philadelphia, Pa		May 2, 1906
MEEM, JAMES COWAN. Engr. for Cranford Co., 190 Montague St., Brooklyn, N. Y	Assoc. M. M.	April 1, 1896 April 4, 1905
MEES, CURTIS ADOLPH. Designing Engr., Southern Power Co., Charlotte, N. C	Assoc. M. M.	Sept. 6, 1905 Nov. 2, 1908
MEIGS, MONTGOMERY. U. S. Civ. Engr., U. S. Engr. Office, Keokuk, Iowa		Mar. 5, 1879
MELCHER, FRANK OTIS. Gen. Mgr., C., R. I. & P. Ry., La Salle St. Station, Chicago, Ill		Mar. 3, 1897
MELLISS, DAVID ERNEST. Cons. Civ. and Min. Engr., 802 Fifth Ave., San Rafael, Cal		Oct. 2, 1895
MELVIN, DAVID NEILSON. Supt. and Engr., Am. Linoleum Mfg. Co., Linoleumville, N. Y		July 3, 1878
MENDEN, WILLIAM STEPHEN. Asst. Gen. Mgr. and Chf. Engr., Brooklyn Rapid Transit System, Brooklyn, N. Y		April 4, 1906
MENDIOLA, MANUEL MARIA. Chf. Engr., Rio Grande Impvt. Works, Mexican Govt., Ciudad Juárez, Chihuahua, Mexico		Dec. 5, 1906

		Date of Membership.
Mensch, Leopold Jehud. Gen. Contr., 646 West Lake St., Chicago, Ill.		Oct. 4, 1905
Mercer, Charles Hatton. Chf. Engr., Bridge and Constr. Dept., The Pennsylvania Steel Co., Steelton, Pa.	Assoc. M. M.	Nov. 3, 1897 May 1, 1901
Meredith, Wynn. 907 Union Trust Bldg., San Francisco, Cal.		June 1, 1909
Merrill, George Nathan. Civ. and Cons. Engr. (Geo. N. Merrill & Co.), 274 Main St., Springfield, Mass.		May 1, 1889
Merrill, William Fessenden. 830 Carlton Ave., Plainfield, N. J.		April 1, 1874
Merriman, Mansfield. Cons. Engr., 32 West 40th St., New York City	Jun. M.	May 12, 1875 Sept. 3, 1884
Merritt, David Spencer. 104 Grove St., Tarrytown, N. Y.		Jan. 4, 1905
Merryman, William Curtis. Res. Engr., Rapid Transit Subway Constr. Co., 165 Broadway (Res., 537 West 149th St.), New York City		Oct. 4, 1899
Mersereau, Charles Vernon. 1324 Chemical Bldg., St. Louis, Mo.		Dec. 3, 1884
Mershon, Ralph Davenport. Con. Engr., 60 Wall St., New York City		April 3, 1907
Meryweather, Henry Francis. Chf. Asst. Engr., Board of Public Works, 1276 Corona St., Denver, Colo.		April 1, 1908
Metcalf, Leonard. (Metcalf & Eddy, Cons. Engrs.), 14 Beacon St., Boston, Mass.	Assoc. M. M.	Jan. 5, 1898 Sept. 2, 1903
Meyer, Rudolf. Inspecting Engr., Water-Works and Sewerage System, Monterey, Mexico		Oct. 5, 1898
Middlebrook, Charles Trinder. Cons. Engr., 82 State St., Albany, N. Y.		Nov. 30, 1909
Miles, John Wiley. Care, American Club, City of Mexico, D. F., Mexico	Assoc. M. M.	Oct. 2, 1901 April 6, 1909
Millard, Charles Sterling. Engr., M. of W., C., C., C. & St. L. Ry., Indianapolis, Ind.	Jun. Assoc. M. M.	May 2, 1899 June 5, 1901 Jan. 31, 1905
Miller, Charles Henry. Engr., River Protection, Mo. Pac. Ry. Co., St. Louis, Mo.		May 2, 1899
Miller, Edward Furber. Prof. of Steam Engr., Mass. Inst. Tech., Boston (Res., 538 Ward St., Newton Center), Mass.		June 3, 1903
Miller, Frank. Cons. Engr. (Long & Miller), 220 Broadway, New York City		Oct. 5, 1904
Miller, Harvey Cooper. Concrete Engr. (H. C. Miller & Co.), 1 Madison Ave., New York City		June 5, 1901
Miller, Hiram Allen. Chf. Engr., Charles River Basin Comm., 367 Boylston St., Boston (Res., 15 Duncklee St., Newton Highlands), Mass.		May 6, 1896

		Date of Membership.
Miller, Rudolph Philip. Supt. of Bldgs., Borough of Manhattan, 220 Fourth Ave., New York City	Jun. Assoc. M M.	Jan. 2, 1890 April 7, 1897 Jan. 5, 1904
Miller, Spencer. Chf. Engr., Cableway Dept., Lidgerwood Mfg. Co., 96 Liberty St., New York City	Assoc. M.	July 3, 1889 Nov. 7, 1894
Millis, John. Lt.-Col., Corps of Engrs., U. S. A., 813 Prospect Ave., S. E., Cleveland, Ohio		Mar. 7, 1900
Mills, Arthur Lorenzo. Pres., Peat Industry Co., Apartado 107 Bis, City of Mexico, Mexico		May 2, 1888
Mills, Charles Malon. Cons. Engr., The E. E. Smith Contr. Co., 71 Broadway, New York City; Res., 4813 Beaumont Ave., Philadelphia, Pa	Jun. M.	June 2, 1886 Sept. 3, 1890
Miner, Charles Augustine. Metropolitan Bank Bldg., Washington, D. C	Assoc. M. M.	April 7, 1897 Dec. 4, 1901
Miner, Edward Fuller. Pres., Central Bldg. Co., Worcester, Mass		June 3, 1908
Minor, Edward Eastman. Asst. Engr. with Albert B. Hill; Cons. Engr., 493 Edgewood Ave., New Haven, Conn	Jun. M.	May 1, 1900 Mar. 4, 1908
Mitchell, Charles Hamilton. Hydro-Elec. Engr., Traders Bank Bldg., Toronto, Ont., Canada	Assoc. M. M.	June 4, 1902 Jan. 5, 1904
Mitchell, Samuel Phillips. Pres., Seaboard Constr. Co. and Am. Equipment Co., 1024 Witherspoon Bldg., Philadelphia, Pa		April 1, 1903
Mitchell, William Selby. U. S. Engr. Office, Custom House, St. Louis, Mo.		June 1, 1909
Mixer, Charles Adam. Engr., Rumford Falls Power Co., Rumford, Me.		Nov. 1, 1893
Moberly, Frank. Barrie, Ont., Canada		Oct. 7, 1903
Modjeski, Ralph. Cons. Engr., 1750 Monadnock Bldg., Chicago, Ill.	Jun. Assoc. M. M.	Dec. 1, 1886 July 1, 1891 Mar. 3, 1897
Mogensen, Olaf Einar. Engr., F. L. Smidth & Co., 50 Church St., Room 459, New York City	Assoc. M. M.	April 7, 1897 Sept. 2, 1903
Mogensen, Peter. 505 Columbia Bldg., Spokane, Wash		July 10, 1907
Mohun, Edward. Union Club, Victoria, B. C., Canada		April 6, 1892
Moir, Ernest William. 10 Victoria St., Westminster, London, England		Sept. 7, 1904
Moisseiff, Leon Solomon. Engr. in Chg., Dept. of Bridges, Park Row Bldg., New York City	Jun. Assoc. M. M.	Dec. 3, 1895 Sept. 5, 1900 Dec. 3, 1907
Molera, Eusebius Joseph. 2025 Sacramento St., San Francisco, Cal		Oct. 5, 1904
Molitor, David Albert. Prof. of Topographic and Geodetic Eng., Cornell Univ., Ithaca, N. Y		Oct. 6, 1897
Molitor, Frederic. Cons. Engr., 79 Wall St., New York City.		Nov. 4, 1896

		Date of Membership.
Moncrieff, Alexander Bain. Railways Commr., Adelaide, South Australia		July 4, 1894
Moncrieff, John Mitchell. Pearl Bldgs., Newcastle-upon-Tyne, England		Nov. 3, 1897
Moncure, William Augustus. Engr. of R. of W., P. R. R., Broad St. Station, Philadelphia, Pa	Jun. Assoc. M. M.	June 21, 1894 Oct. 7, 1896 June 5, 1906
Monroe, Richard. U. S. Asst. Engr., U. S. Engr. Office, Rock Island, Ill		June 1, 1909
Monroe, Will Klahr. Engr. in Chg. of Estimating, The Brown Hoisting Machinery Co., Cleveland, Ohio		Oct. 7, 1908
Montfort, Richard. Cons. Engr., L. & N. R. R., Louisville, Ky.		June 6, 1888
Montgomery, John Alexander. Cons. Engr., Room 905, First National Bank Bldg., Birmingham, Ala		Jan. 1, 1896
Moody, Burdett. Cons. Min. Engr., 1043 San Pasqual St., Pasadena, Cal	Assoc. M. M.	Feb. 3, 1897 June 5, 1901
Moore, Charles Edward. Cons. Engr., Santa Clara, Cal		Jan. 7, 1880
Moore, Charles Gillingham. 744 Ellicott Sq., Buffalo, N. Y.	Assoc. M. M.	Mar. 5, 1902 June 1, 1909
Moore, Charles Harry. Engr. of Grade Crossings, Erie R. R., Chic. & Erie R. R., Nypano R. R., N. Y., S. & W. R. R.; Chf. and Cons. Engr., Ferrocarril al Curaray, Ecuador, 50 Church St., New York City	Assoc. M. M.	April 5, 1893 Sept. 4, 1901
Moore, Fred Forrest. Designing Engr., Board of Water Supply, 299 Broadway, New York City		April 3, 1907
Moore, James Edwin Alexander. Cons. and Contr. Engr. with J. W. Seaver, Cleveland, Ohio		June 5, 1901
Moore, John Edwin. Chemist for Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill		Oct. 5, 1904
Moore, John William. Chf. Engr., Indianapolis and Cincinnati Traction Co., Rushville, Ind		Feb. 2, 1909
MOORE, ROBERT. (*Past-President*). Cons. Engr., Merchants-Laclede Bldg., St. Louis, Mo		April 5, 1876
Moore, William Edwin. Cons. Engr., 719 Peyton Bldg., Spokane, Wash		Feb. 7, 1906
Moore, William Harley. Engr. of Bridges, N. Y., N. H. & H. R. R., New Haven, Conn		June 4, 1895
Moran, Daniel Edward. Vice-Pres., Foundation Co., 115 Broadway, New York City	Assoc. M. M.	June 3, 1891 Jan. 1, 1896
Mordecai, Augustus. Cons. and Const. Engr., 1328 Citizens Bldg., Cleveland, Ohio		Feb. 1, 1893
Moritz, Charles Holland. Gen. Supt., Aluminum Co. of America, Niagara Falls, N. Y.	Assoc. M. M.	Oct. 2, 1901 April 2, 1907
Morley, Fred. Lapeer, Mich	Assoc. M. M.	May 6, 1891 Mar. 4, 1896

		Date of Membership.
Morrill, George Sullivan. 44 Tremlett St., Dorchester, Mass.		Mar. 2, 1887
Morris, Charles John Augustus. Cons. Engr. and Contr., P. O. Box 254, St. Paul, Minn.		Oct. 3, 1883
Morris, Clyde Tucker. Prof. of Structural Eng., Ohio State Univ., Columbus, Ohio	Assoc. M. M.	Mar. 6, 1907 Nov. 8, 1909
Morris, Henry Gurney. Engr. and Machinist, 333 Walnut St., Philadelphia, Pa.		Dec. 4, 1867
Morris, Lardner Vanuxem. Chf. Engr., Bay Ridge Impvt., Long Island R. R., 1964 Broadway, Brooklyn, N. Y.		May 3, 1905
Morris, Marshall. Civ. and Cons. Engr., 303 Norton Bldg., Louisville, Ky.		Mar. 5, 1873
Morris, William Cullen. Engr. of Constr., Consolidated Gas Co. of New York and The Astoria Light, Heat & Power Co., 4 Irving Pl., New York City		Oct. 7, 1908
Morrison, Harry Johnson. Box 477, Walden, Orange Co., N. Y.	Assoc. M. M.	Jan. 4, 1899 April 4, 1905
Morrison, Henry Prentice. Broadway and Forest Ave., West New Brighton, N. Y.		April 6, 1898
Morrison, Thomas John. 41 Triangle Bldg., Rochester, N. Y.		April 6, 1909
Morrow, Jay Johnson. Maj., Corps of Engrs., U. S. A., 920 Seventeenth St., N. W., Washington, D. C.	Assoc. M. M.	June 5, 1901 Mar. 1, 1904
Morse, Benjamin Franklin. 2187 E. 71st St., S. E., Cleveland, Ohio		July 12, 1877
Morse, Charles Adelbert. Chf. Engr., "Sante Fe" System, 1021 Van Buren St., Topeka, Kans.		April 6, 1898
Morse, Charles James. 1825 Asbury Ave., Evanston, Ill.		Feb. 6, 1884
Morse, Charles Miller. Mech. Engr., Erie County Bank Bldg. (Res., 246 Bryant St.), Buffalo, N. Y.		Jan. 2, 1895
Morse, Edwin Kirtland. 1801 Commonwealth Bldg., Pittsburg, Pa.		June 6, 1900
Morse, George Frederick. 601 Ave. E, Bayonne, N. J.		April 3, 1907
Morse, William Prentiss. Asst. City Engr. of Newton; Address, City Hall, West Newton, Mass.		May 4, 1909
Morton, Walter Scott. (Morton & Burritt), 2 Rector St., New York City		Oct. 3, 1906
Moses, John Cranch. Engr. of Constr., The Boston Bridge Works, Inc., Cambridge, Mass.	Jun. Assoc. M. M.	July 2, 1890 May 4, 1898 May 3, 1904
Mosman, Alonzo Tyler. Asst., U. S. Coast and Geodetic Survey, Washington, D. C.		July 1, 1885
Mosscrop, Alfred Mitton. Director, Dorman, Long & Co., Ltd., Middlesbrough, England; Res., 399 Oxford St., Rochester, N. Y.	Jun. Assoc. M. M.	May 4, 1887 May 3, 1893 Oct. 4, 1899

		Date of Membership.
Moulton, Guy. Div. Engr., Middle Div., New York State Canals, Canal Office (Res., 216 W. Kennedy St.), Syracuse, N. Y.		Mar. 1, 1905
Mowlds, Eugene. Engr., Edge Moor Plant, Am. Bridge Co., Edge Moor, Del.		Oct. 2, 1907
Muenscher, Emory Washburn. County Engr., Manistee County, Manistee, Mich.		July 5, 1893
Mueser, William. Member, Concrete-Steel Eng. Co., Park Row Bldg., New York City		Feb. 7, 1906
Muhs, Frederick Ross. Crocker Bldg., San Francisco, Cal.		Oct. 7, 1908
Mulholland, William. Supt., Los Angeles Water Dept., 440 S. Hill St., Los Angeles, Cal.		Feb. 6, 1907
Müller, Ejnar Jönsberg. Engr. in Chf., Anhui Ry. Co., Wuhu, China		Jan. 8, 1908
Münster, Andrew Wendelbo. Cons. Engr., 61 Maynard Bldg., Seattle, Wash.		May 1, 1889
Muralt, Carl Leonard de. Prof. of Elec. Eng., Univ. of Michigan; Cons. Engr. (Muralt & Co.), 114 Liberty St., New York City		Aug. 31, 1909
Murphy, Daniel William. Engr. in Chg. of Washington Office Eng., U. S. Reclamation Service, Washington, D. C.		Feb. 2, 1909
Murphy, Edward Charles. Engr., U. S. Geological Survey, 2338 Carlton St., Berkeley, Cal.	Assoc. M. M.	Sept. 5, 1900 Mar. 31, 1908
Murray, John Francis. Asst. to Chf. Engr., P. R. R., Broad St. Station, Philadelphia, Pa.		Mar. 7, 1906
Murtaugh, Mark Maurice. Cons. Hydr. and Constr. Engr., Alta Club, Salt Lake City, Utah		May 1, 1907
Musson, Eugene Francis. City Engr., Norwich, N. Y.		May 2, 1906
Myers, Charles Hayward. 45 Broadway, New York City		Aug. 5, 1868
Myers, Edmund Trowbridge Dana, Jr. Pres., Richmond Iron Works, Richmond, Va.	Jun. M.	May 2, 1888 June 7, 1899
Nagle, James C. Prof. of Civ. Eng., Agri. and Mech. Coll. of Texas, College Station, Tex.	Assoc. M. M.	April 5, 1899 June 6, 1905
Nauman, George. Asst. Engr., Constr., P. R. R., 406 First National Bank Bldg., Sunbury, Pa.		May 4, 1904
Neale, John Colwell. Structural Engr., Carnegie Steel Co., Carnegie Bldg., Pittsburg, Pa.		Jan. 7, 1903
Neeld, Charles Marshall. Mgr., Pittsburg Plant, McClintic-Marshall Constr. Co., 2243 Cambridge Ave., West Liberty, Pittsburg, Pa.		Oct. 7, 1908
Neely, William Ridley. Asst. Engr., in Chg. of Section, Board of Water Supply of New York City, New Paltz, N. Y.		July 9, 1906
Neher, Clarence Rufus. Box 724, Whitehall, N. Y.		June 4, 1902
Neher, Frank. Constr. Dept., Mo. Pac. Ry., St. Louis, Mo.		Oct. 4, 1905

		Date of Membership.
NEILSON, GEORGE HARRISON. Gen. Mgr., Braeburn Steel Co., Braeburn, Pa.		Oct. 5, 1904
NELSON, JAMES AUGUSTUS. 800 Westinghouse Bldg., Pittsburg, Pa.		Mar. 2, 1909
NETHERCUT, EDGAR S. Cons. Engr., Room 409, Ashland Blk., Chicago, Ill.		April 6, 1904
NEWBROUGH, WILLIAM. Civ. and Min. Engr., Evanston, Wyo.		April 6, 1904
NEWELL, FREDERICK HAYNES. Director, U. S. Reclamation Service, Washington, D. C.		Dec. 5, 1900
NEWELL, JOSEPH PETTUS. 33 Washington Bldg., Portland, Ore.		Oct. 2, 1907
NEWMAN, EMIL. Chf. Engr., Fresno & Yosemite Val. R. R., 1048 West 8th St., Los Angeles, Cal.		Jan. 4, 1905
NEWMAN, ROBERT MORRIS. Jackson, Mich.		May 6, 1874
NEWTON, ALBERT WILLIAM. Gen. Insp., Permanent Way and Structures, C., B. & Q. R. R., Chicago, Ill.		Dec. 6, 1905
NEWTON, RALPH EELLS. Pres., Newton Eng. Co., 434 Jackson St., Milwaukee, Wis.	Assoc. M. M.	Jan. 8, 1902 Feb. 2, 1909
NICHOL, JOHN. Western Springs, Cook Co., Ill.	Assoc. M.	Oct. 2, 1872 April 5, 1876
NICHOLS, CHARLES HART. 42 East 23d St., New York City.		Nov. 8, 1909
NICHOLS, CHARLES HENRY. Cons. Civ. Engr.; Engr., Conn. Shell Fish Comm., New Haven, Conn.	Jun. Assoc. M. M.	May 2, 1893 May 2, 1900 Feb. 28, 1905
NICHOLS, EDWIN JAY. Supt. for Horton & Horton, Gen. Contrs., Prince Theater Bldg., Houston, Tex.		Sept. 2, 1896
NICHOLS, LEWIS ABEL. Cons. Engr.; Pres., Chicago Steel Tape Co., 6231 Cottage Grove Ave., Chicago, Ill.		Oct. 5, 1892
NICHOLS, WILLARD ATHERTON. Redlands, Cal.		May 7, 1873
NICHOLSON, FRANK LEE. Chf. Engr., Norfolk & Southern Ry. Co., Norfolk, Va.		Dec. 6, 1905
NICOLLS, WILLIAM JASPER. 528 Walnut St., Philadelphia, Pa.		June 5, 1878
NICOLSON, GEORGE LLEWELLYN. Gen. Mgr., C. & O. Canal, Washington, D. C.		Dec. 5, 1894
NOBLE, ALFRED. (*Past-President*). 7 East 42d St., New York City	Jun. M.	Sept. 2, 1874 April 3, 1878
NOBLE, THERON AUGUSTUS. Cons. Engr., 207 Miller Bldg., North Yakima, Wash.		June 2, 1897
NORBOE, PAUL MANINGHAM. Asst. State Engr., 3730 Magnolia Ave., Sacramento, Cal.		Nov. 1, 1905
NORCROSS, JOSEPH ARNOLD. Secy. and Treas., The New Haven Gas Light Co., 80 Crown St., New Haven. Conn.		April 5, 1905
NORRIS, ROBERT VAN ARSDALE. Cons. Engr., 524 Second National Bank Bldg., Wilkes-Barre, Pa.	Jun. M.	Dec. 7, 1887 Mar. 5, 1902
N. NORTH, EDWARD P. 220 West 57th St., New York City.		Dec. 4, 1867
NORTON, ALBERT GRAY. Res. Engr., Erie R. R., Otisville, N. Y.		Dec. 4, 1901

		Date of Membership.
Norton, Homer Burdett. Chf. Engr., Elk Tanning Co., Ridgway, Pa.		June 3, 1908
Nostrand, Peter Elbert. Cons. Engr. and City Surv., 149 Broadway, New York City	Assoc. M. M.	Sept. 7, 1892 Mar. 6, 1895
Noyes, Ellis Bradford. Civ. Engr.'s Office, U. S. Navy Yard, Norfolk, Va.	Jun. M.	July 7, 1880 Oct. 2, 1889
Nuebling, Emil Louis. Supt. and Engr., Dept. of Water, Reading, Pa.		Dec. 7, 1904
Nunn, Paul N. Chf. Engr., Telluride Power Co., Provo, Utah		Sept. 7, 1904
Nyeboe, Marius Ib. Esperance Alle 12, Charlottenlund, Denmark		July 9, 1906
Oakley, Frank Thompson. Bridge Engr., Northwestern Pacific R. R., San Francisco; Address, 2 Mesa Ave., Oakland, Cal.	Assoc. M. M.	Feb. 6, 1895 June 6, 1900
Ober, Ralph Hadlock. Asst. City Engr., City Hall, Seattle, Wash.		Dec. 4, 1907
O'Brien, Arthur. 315 Mary St., Utica, N. Y.		July 1, 1909
O'Brien, Joseph Henry. Res. Civ. Engr., P. R. R., N. Y. Terminal, with Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	Assoc. M. M.	May 1, 1901 Sept. 5, 1905
Ockerson, John Augustus. Cons. Engr.; Member, Mississippi River Comm., 1301 Liggett Bldg., St. Louis, Mo.		July 7, 1880
Odell, Frederick Sylvester. Port Chester, N. Y.		Mar. 5, 1884
O'Donnell, John Patrick. Palace Chambers, Westminster, London, S. W., England		July 5, 1893
Oestreich, Henry Lewis. Asst. Engr., Public Service Comm., 154 Nassau St. (Res., 2092 Bathgate Ave.), New York City	Jun. Assoc. M. M.	Oct. 4, 1892 Dec. 6, 1899 April 6, 1909
Ogawa, Umesaburo. Prof. of Civ. Eng., Kyoto Imperial Univ., Kyoto, Japan		Dec. 4, 1907
Ogden, Henry Neely. Prof. of San. Eng., Cornell Univ., Ithaca, N. Y.	Jun. Assoc. M. M.	Oct. 3, 1893 Oct. 5, 1898 Nov. 30, 1909
O'Hanly, John Lawrence Power. Cons. Engr., Ottawa, Ont., Canada		Sept. 5, 1883
Olcott, Eben Erskine. Min. Engr., 36 Wall St., New York City		July 5, 1893
Oliver, Emery. Div. Engr., West. Pac. Ry. Co., Oroville, Cal.		Mar. 7, 1906
Olmsted, Ashbel Edward. Div. Engr., R. T. S. Cons. Co.; Res., 78 Madison Ave., New York City		May 6, 1903
Olmsted, Frank Henry. Cons. Engr. (Olmsted & Gillelen), 604 Wright & Callender Bldg., Los Angeles, Cal.		Feb. 7, 1900
Olney, Alfred Clarence. 1015 Central Ave., Birmingham, Ala.	Jun. M.	April 30, 1895 Nov. 2, 1898
Olney, LaFayette. Civ. Cons. Engr., Mahwah, N. J.		Oct. 7, 1868

		Date of Membership.
OPDYKE, STACY BROWN, JR. Contr. Engr., 1931 Broadway, New York City		Feb. 2, 1876
ORANGE, JAMES. 3 Gray's Inn Sq., London, England		Dec. 3, 1890
O'ROURKE, JOHN FRANCIS. Pres., O'Rourke Eng. Constr. Co.; Cons. Engr., 345 Fifth Ave., New York City		April 2, 1884
ORROK, GEORGE ALEXANDER. Mech. Engr., New York Edison Co., 55 Duane St., New York City		June 6, 1906
OSBORN, FRANK CHITTENDEN. Pres., The Osborn Eng. Co., Osborn Bldg., Cleveland, Ohio		Oct. 3, 1888
OSGOOD, JOSEPH OTIS. Chf. Engr., C. R. R. Co. of N. J., 143 Liberty St., New York City	Jun. M.	May 3, 1876 Mar. 5, 1879
O'SHAUGHNESSY, MICHAEL MAURICE. Cons. Engr.; Chf. Engr., Southern California Mountain Water Co., 514 Union Trust Bldg., San Francisco, Cal.		June 4, 1902
OSTRANDER, JOHN EDWIN. Prof., Mathematics and Civ. Eng., Mass. Agri. Coll., Amherst, Mass.	Jun. Assoc. M. M.	May 2, 1888 Sept. 2, 1891 April 4, 1905
OSTROM, JOHN NELSON. Bridge Engr., 1626 Farmers Bank Bldg., Pittsburg, Pa.		Nov. 5, 1890
OSTRUP, JOHN CHRISTIAN. Prof. of Structural Eng., Stevens Inst. of Tech., Hoboken, N. J.; Cons. Engr., 203 West 103d St., New York City	Assoc. M. M.	Mar. 4, 1896 Mar. 1, 1899
OTAGAWA, MASAYUKI. 57 Haramachi Itchome, Ushigomeku, Tokyo, Japan		Jan. 2, 1895
OTIS, GEORGE ELLISON. Cons. Engr.; Pres., Otis Lumber Co., Mansfield, Ark.		July 3, 1895
OWEN, JAMES. Cons. Engr., 196 Market St., Newark, N. J.		Sept. 15, 1869
OWENS, HENRY KINDER. Chf. Engr., Hanford Irrig. & Power Co., 839 Central Bldg., Seattle, Wash.		Mar. 6, 1889
OXHOLM, THEODOR SMIDT. Engr. in Chg., Bureau of Eng.-Constr., Office, Pres. of the Borough of Richmond, Borough Hall, New Brighton, N. Y.		Nov. 3, 1897
PACKARD, RALPH GOODING. Pres. of the R. G. Packard Co., 130 Pearl St., New York City		Feb. 17, 1869
PAGE, LOGAN WALLER. Director, Office of Public Roads, U. S. Dept. of Agriculture, 2223 Mass. Ave., Washington, D. C.		July 1, 1909
PAGE, WILLIAM NELSON. 1863 Kalorama Rd., Washington, D. C.		May 3, 1905
PAGET, EDMUND WINTER. 266 Twelfth St., Portland, Ore.		June 5, 1901
PAINE, ARTHUR BICKLEY. Care, Chas. E. Walker, Tucson, Ariz.		Sept. 6, 1882
PALMER, FREDERICK. Chf. Eng., Port of London Authority, 109 Leadenhall St., London, E. C., England		Oct. 4, 1899
PALMER, JOHN ELDEN. 32 Lindsey St., Dorchester, Mass.		June 1, 1904

		Date of Membership.
Palmer, John Geary. Asst. Engr., New York State Barge Canal, Montezuma, N. Y.		Oct. 7, 1908
Pardee, James Thomas. Cons. Engr., 10220 Clifton Boulevard, N. W., Cleveland, Ohio	Assoc. M. M.	June 5, 1895 June 5, 1901
Paret, Milnor Peck. 317 N. Y. Life Bldg.. Kansas City, Mo.		Sept. 2, 1885
Parker, Adelbert Franklin. Cons. Engr., 585 Twenty-eighth St., Ogden, Utah		Aug. 31, 1909
Parker, Charles Jeremiah. Prin. Asst. Engr., N. Y. C. & H. R. R. R. Co., 335 Madison Ave., New York City		Feb. 7, 1900
Parker, Frederick Yancy. U. S. Engr. Office, Custom House, St. Louis, Mo.		June 1, 1909
Parker, Harold. Member, Mass. Highway Comm.; Member, Wachusett Mt. State Reservation Comm.; (Parker & Bateman), Clinton (Res., So. Lancaster), Mass.		June 7, 1899
Parker, Maurice Stiles. With Stone & Webster Engr. Corp., Helena, Mont.		Feb. 5, 1890
Parker, Orlando Kenton. Cons. Engr., Suite 1115, Union Trust Bldg., Los Angeles, Cal.		June 6, 1906
Parker, William Pool. Chf. Engr., A. M. Blodgett Constr. Co., 411 Security Bldg., Galveston, Tex.	Assoc. M. M.	Oct. 5, 1904 Sept. 1, 1908
Parks, Charles Wellman. Civ. Engr., U. S. N., Navy Yard, Bremerton,. Wash.		Oct. 3, 1906
Parks, Oren Elisha. Town Engr. and Engr. of Westfield Water-Works, 111 North Elm St., Westfield, Mass.		Dec. 6, 1905
Parmley, Walter Camp. Cons. Engr., Everett Bldg., New York City	Assoc. M. M.	April 1, 1896 June 1, 1898
Parsons, Burt Hewitt. Prin. Asst. to Hugh L. Cooper, Cons. Engr., 60 Wall St., New York City		Feb. 6, 1907
Parsons, Harry de Berkeley. Prof. Emeritus, Rensselaer Polytechnic Inst.; Cons. Engr., 22 William St., New York City		Feb. 3, 1897
Parsons, Henry Cuyler. Tweddle Bldg., Albany, N. Y.		Oct. 6, 1886
Parsons, Robert Stevens. Supt., Susquehanna and Tioga Divs., Erie R. R., Hornell, N. Y.		Sept. 6, 1905
Parsons, William Barclay. Cons. Engr., 60 Wall St., New York City	Jun. M.	June 7, 1882 Nov. 2, 1887
Paschke, Theodore. 1 West 100th St., New York City		Mar. 7, 1894
Patch, Walter Woodbury. Project Engr., U. S. Reclamation Service, Klamath Falls, Ore.	Assoc. M. M.	Sept. 7, 1904 Jan. 7, 1908
Paterson, Harry Thomas. U. S. Asst. Engr., Beaufort, N. C.	Assoc. M. M.	Feb. 3, 1904 May 4, 1909
Patrick, Mason Mathews. Maj., Corps of Engrs., U. S. A., Custom House, Norfolk, Va.		Oct. 7, 1903
Patten, Henry Benjamin. 314 East 18th St., Cheyenne, Wyo.		Jan. 4, 1888

MEMBERS P

		Date of Membership.
Patterson, John Curtis. Gen. Mgr., Gatzmer Coal & Coke Co., 200 Franklin Bank Bldg., Philadelphia, Pa.		Oct. 2, 1889
Patterson, William Rodney. 1448 Monadnock Blk., Chicago, Ill.		May 4, 1909
Paul, Charles Howard. Project Engr., U. S. Reclamation Service, Rupert, Idaho	Assoc. M. M.	June 7, 1905 Sept. 1, 1908
Payne, Edwin Van Rensselaer. Barge Canal Res. Engr., Fort Edward, N. Y.		May 6, 1908
Payne, William Arthur. Gen. Supt. of Constr. and Engr. with Charles T. Wills, Inc., 156 Fifth Ave., New York City		Feb. 1, 1910
Peabody, William Welcome. Div. Engr., Board of Water Supply, New York City, White Plains, N. Y.		April 6, 1909
Pearl, James Warren. Asst. Engr., City of Chicago, 5300 So. Park Ave., Chicago, Ill.		Jan. 2, 1889
Pearl, Walter. Cons. Engr., 14, The Pleasanton, 18th and Welton Sts., Denver, Colo.		June 3, 1908
Pearson, Edward Jones. Chf. Engr., Chic., Mil. & Puget Sound Ry., 617 White Bldg., Seattle, Wash.		Dec. 4, 1907
Pearson, Fred Stark. Cons. Engr., 25 Broad St., New York City		Nov. 3, 1897
Peary, Robert Edwin. Civ. Engr., U. S. N., 2014 Twelfth St., N. W., Washington, D. C.		Mar. 3, 1886
PEGRAM, GEORGE HERNDON. (*Vice-President*). Chf. Engr., Interborough Rap. Trans. Co. and Rap. Trans. Subway Constr. Co., 165 Broadway, New York City	Jun. M.	April 7, 1880 Jan. 3, 1883
Peimbert, Angel. Res. Engr., S. Pearson & Son, Ltd., Puente Alvarado No. 15, City of Mexico, Mexico		July 9, 1906
Pemoff, Joel Juk. Asst. Engr., Dept. of Docks and Ferries, in Chg. of the Chelsea Section, Pier A, North River, New York City	Assoc. M. M.	Nov. 5, 1902 Nov. 2, 1908
Pence, William David. Prof. of Railway Eng., Univ. of Wisconsin; Engr., Wisconsin State Board of Assessment and Railroad Comm. of Wisconsin, Madison, Wis.		Oct. 4, 1899
Penfield, William Henry. Engr. of Constr., C., M. & St. P. Ry. Co. of Mont.; Chf. Engr., Montana R. R., Butte, Mont.		Mar. 1, 1905
Perkins, Charles Ezra. Chf. Engr., Public Works of Ohio, Columbus, Ohio		June 6, 1906
Perkins, Charles Penrose. 2005 De Lancey St., Philadelphia, Pa.	Jun. M.	Feb. 3, 1875 April 5, 1882
Perkins, Edmund Taylor. Engr. in Chg., U. S. Reclamation Service, Federal Bldg., Chicago, Ill.		Dec. 3, 1902
Perrilliat, Arsène. Cons. Engr., 407 Cotton Exchange Bldg., New Orleans, La.	Assoc. M. M.	June 7, 1893 April 5, 1899

Member	Grade	Date of Membership.
Perrine, George. 820 West End Ave., New York City		April 6, 1909
Perry, Chauncy Rusch. Greenwood Ave., Waltham, Mass	Assoc. M. M.	Feb. 1, 1905 June 1, 1909
Peterson, Peter Alexander. Mount Royal Club, Montreal, Que., Canada		Jan. 5, 1876
Pettee, Eugene Everett. (J. R. Worcester & Co., Cons. Engrs.), 79 Milk St., Boston, Mass	Assoc. M. M.	Sept. 3, 1902 Mar. 2, 1909
Pettigrew, Thomas. Johnstone Bldg., Broadway and 28th St., New York City		Oct. 4, 1893
Pew, Arthur. Cons. Engr., 50 Columbia Ave., Atlanta, Ga		Dec. 2, 1885
Peyton, John Howe. Asst. to Pres., L. & N. R. R. Co., Louisville, Ky		June 1, 1909
Pharr, Harry Nelson. Cons. Engr., 216 Randolph Bldg., Memphis, Tenn	Assoc. M. M.	Oct. 3, 1900 June 6, 1905
Phelps, William Collins. 21 Park Row, Room 2324, New York City		Oct. 2, 1907
Philips, James Harry. Prin. Asst. to Engr. and Supt. of Essex County Park Comm., 60 Clifton Ave. (Res., 27 Ninth Ave.), Newark, N. J		Feb. 6, 1907
Phillips, Alfred Edward. Prof., Civ. Eng., Armour Inst. of Tech., 1206 Morse Ave., Chicago, Ill		May 3, 1905
Phillips, Arthur Louis. 911 Hibernia Bank Bldg., New Orleans, La		Nov. 4, 1903
Phillips, Asa Emory. Supt., Sewer Dept., D. C., District Bldg., Washington, D. C	Jun. Assoc. M. M.	Nov. 5, 1891 Dec. 7, 1898 Sept. 4, 1901
Phillips, Hiram. Cons. Hydr. and San. Engr., 644 Frisco Bldg., St. Louis, Mo	Assoc. M. M.	Jan. 3, 1894 Nov. 3, 1897
Phillips, Joseph Leslie. Mgr., Gold Rd. Min. & Ex. Co., 2159 West 25th St., Los Angeles, Cal		Nov. 3, 1897
Phillips, Richard Harvey. Cons. Civ. Engr., Security Bldg., St. Louis, Mo		Dec. 7, 1904
Phillips, William Renton. 419 Lumber Exchange Bldg., Portland, Ore		June 1, 1909
Pickett, William Douglas. 228 Campsie St., Lexington, Ky.		July 6, 1853
Pierce, Frederic Emery. Chf. of Constr., The New Jersey Zinc Co., 55 Wall St., New York City		Oct. 5, 1909
Pierce, Henry. Engr., Constr., C. & O. Ry., Richmond, Va		Dec. 5, 1894
Pierce-Hope, John. Mgr., Guaqui to La Paz Ry., Casilla 280, La Paz, Bolivia		Dec. 5, 1906
Pierson, George Spencer. Civ., Hydr. and San. Engr., Kalamazoo, Mich		June 5, 1889
Pihl, Olaf Ridley. 637 Wabash Bldg., Pittsburg, Pa		Oct. 2, 1889
Pitcher, Samuel Henry. 418 Main St., Worcester, Mass		Mar. 2, 1909
Pitman, Frederick Longfellow. Chf. Engr., The North Coast R. R. Co., 9th Floor, Paulsen Bldg., Spokane, Wash		Oct. 5, 1909

		Date of Membership.
PITZMAN, JULIUS. 615 Chestnut St., St. Louis, Mo.		Dec. 4, 1907
PLIMPTON, ARTHUR LESLIE. Civ. Engr. in Chg. of Dept. of Civ. Eng., Bost. Elev. Ry. Co., 101 Milk St., Boston, Mass.		May 6, 1896
POETSCH, CHARLES JULIUS. City Engr. and Pres., Board of Public Works, Milwaukee, Wis.	Jun. M.	May 4, 1881 May 2, 1883
POLAND, WILLIAM BABCOCK. Vice-Pres. and Chf. Engr., Philippine Ry. Co., Manila, Philippine Islands	Jun. Assoc. M. M.	Oct. 31, 1893 May 3, 1899 Sept. 2, 1903
POLHEMUS, JAMES SUYDAM. U. S. Asst. Engr., Custom House, Portland, Ore.		Oct. 3, 1894
POLLEDO, YSIDORO. Manzaneda 16, Matanzas, Cuba	Jun. M.	Jan. 2, 1889 Nov. 4, 1903
POLLEYS, WILLIAM VAUGHAN. Supt. of Constr., Stone & Webster Engr. Corp., Jacksonville, Fla.		Jan. 3, 1906
POLLOCK, CLARENCE DUBOIS. Asst. Engr., Highways, Borough of Manhattan, 1605 Park Row Bldg., New York City	Assoc. M. M.	Jan. 8, 1902 April 4, 1905
POND, HENRY OTIS. Tenafly, N. J.		May 4, 1909
POPE, JOHN HORTON. Care, Percival Farquhar, 11 Rue Louis le Grand, Paris, France		Dec. 7, 1904
POPE, WILLARD. Vice-Pres. and Engr., The Canadian Bridge Co., Ltd., Walkerville, Ont., Canada		Oct. 5, 1904
PORTER, DWIGHT. Prof. of Hydr. Eng., Mass. Inst. Tech., Boston, Mass.		Oct. 4, 1893
PORTER, HENRY HOBART. 52 William St., New York City		June 3, 1903
PORTER, HENRY TEGMEYER. Chf. Engr., Bessemer & L. E. R. R., Greenville, Pa.		April 1, 1903
POST, GEORGE BROWNE. 347 Fifth Ave., New York City		Sept. 2, 1896
POST, HENRY WILLIS. Cons. Structural Engr., 281 Fourth Ave., New York City		Oct. 7, 1903
POST, WALTER A. Gen. Mgr., Newport News Shipbuilding & Dry Dock Co., Newport News, Va.		Mar. 1, 1893
POTTER, CHARLES LEWIS. Maj., Corps of Engrs., U. S. A., Light-House Depot, Tompkinsville, N. Y.		April 1, 1903
POTTER, HENRY WITBECK. Office Engr., Tlahualilo Agri. Co., Tlahualilo, Dgo., Mexico		Dec. 5, 1888
POTTER, HERBERT LEROY. 511 Eighth St., Brooklyn, N. Y.		Oct. 2, 1907
POTTER, WILLIAM BANCROFT. Engr., Railway and Traction Dept., Gen. Elec. Co., Schenectady, N. Y.		Mar. 2, 1904
POWELL, AMBROSE VINCENT. Cons. Civ. Engr., 1007 Chamber of Commerce Bldg., Chicago, Ill.		Feb. 6, 1901
POWELL, ARCHIBALD OLIN. Cons. Civ. Engr., 404 Central Bldg., Seattle, Wash.		Mar. 2, 1898
POWER, GEORGE COFFIN. Ventura, Cal.		Feb. 1, 1893
POWERS, CORNELIUS VAN VORST. Div. Engr., Public Service Comm. for the First Dist., 231 West 125th St., New York City		Mar. 1, 1905

		Date of Membership.
OWERS, JOSEPH ALLEN. Pres., Powers & Mansfield Co., 280 River St., Troy, N. Y.	Jun. M.	April 2, 1884 Sept. 3, 1890
RATT, MASON DELANO. Cons. Engr., 16 South Second St., Harrisburg, Pa.	Jun. Assoc. M. M.	Sept. 5, 1888 Feb. 3, 1897 April 3, 1901
RATT, WILLIAM ABBOTT. Cons. Engr., Waynesboro, Va.		July 5, 1882
RESTON, CHARLES HENRY. Archt. and Structural Engr., 43 Broadway, Norwich, Conn.		Oct. 5, 1909
RESTON, HENRY WRAY. Engr., Elmira Plant, Empire Bridge Co., Elmira Heights, N. Y.	Assoc. M. M.	May 3, 1899 Sept. 3, 1907
RICE, WILLIAM GUNN. 260 Reis St., New Castle, Pa.		April 3, 1895
RICHARD, HENRY SEWALL. Am. Bridge Co., Frick Bldg., Pittsburg, Pa.		Jan. 2, 1895
RINCE, GEORGE THOMAS. Cons. Engr., 1520 Champa St., Denver, Colo.		April 4, 1894
RINDLE, FRANKLIN COGSWELL. Civ. Engr., U. S. N.; Rear-Admiral (*Retired*), 1752 Park Rd., Washington, D. C.		Mar. 4, 1874
RIOR, CHARLES HENRY. 304 South 7th St., Minneapolis, Minn.		Mar. 1, 1882
ROAL, ARTHUR BREESE, JR. Care, Robins Conveying Belt Co., Passaic, N. J.		Mar. 7, 1906
ROUT, HENRY GOSLEE. First Vice-Pres. and Gen. Mgr., Union Switch & Signal Co., 143 Liberty St., New York City	Assoc. M.	Nov. 6, 1872 Sept. 3, 1879
RUYN, FRANCIS LANSING. Vice-Pres., Underpinning Co., 290 Broadway, New York City	Jun. Assoc. M. M.	Dec. 1, 1896 June 7, 1899 Mar. 2, 1909
UFFER, WILLIAM HASELTON. Guanajuato, Mexico		May 3, 1905
UGA, GUILLERMO BELTRAN Y. Direccion de Obras Publicas, City of Mexico, D. F., Mexico		June 5, 1907
UGH, DE WITT PAWLING. Asst. Engr., P. R. R., 56 Trust Bldg., Greensburg, Pa.		May 6, 1908
UGH, MARSHALL ROGERS. (Pugh & Hubbard), 601 Witherspoon Bldg., Philadelphia, Pa.	Assoc. M. M.	Dec. 7, 1904 Nov. 2, 1908
URDON, CHARLES DE LA CHEROIS. 6157 Kingsbury Blvd., St. Louis, Mo.		Mar. 3, 1886
URDY, CORYDON TYLER. Everett Bldg., Union Square North, New York City	Jun. M.	Feb. 2, 1887 Dec. 6, 1893
UTNAM, GEORGE ROCKWELL. U. S. Coast and Geodetic Survey, Washington, D. C.	Assoc. M. M.	Feb. 1, 1899 June 3, 1903
UIMBY, HENRY HODGE. Cons. Bridge Engr., 3920 Girard Ave., Philadelphia, Pa.		Sept. 3, 1890
UINBY, EDWIN RUFUS. Chf. Engr., Con. Tel. & Elec. Subway Co., 66 Lafayette St., New York City		May 4, 1904
UINN, RICHARD. U. S. Asst. Engr., Hilo, Hawaii		Mar. 2, 1904

		Date of Membership.
Quinton, John Henry. Cons. Engr., U. S. Reclamation Service, 4 Quinton Court, 827 Green Ave., Los Angeles, Cal..		Feb. 7, 1900
Quintus, John Charles. U. S. Asst. Engr., 540 Federal Bldg., Buffalo, N. Y.		Jan. 2, 1889
Raasloff, Harald de. 18 Burling Slip, New York City..	Jun. M.	Dec. 3, 1884 July 3, 1895
Rablin, John Richard. Chf. Engr., Met. Park Comm., 14 Beacon St., Boston, Mass.		Aug. 31, 1909
Radenhurst, William Napier. 16 Scio St., Rochester, N. Y.	Jun. M.	July 7, 1875 July 7, 1880
Raikes, Hugh Percival. 63 Temple Row, Birmingham, England	Assoc. M. M.	June 6, 1906 July 1, 1909
Ralston, John Chester. Cons. Engr., 2421 West Mission Ave., Spokane, Wash.		Oct. 3, 1906
Ramsey, Joseph, Jr. 100 Broadway, New York City (Res., 157 Raymond Ave., South Orange, N. J.)		May 1, 1889
Randall, Henry Irwin. Natron, Lane Co., Ore.		Feb. 7, 1906
Randle, George Nelson. City Engr., City Hall, Sacramento, Cal.		Feb. 2, 1909
Randolph, Beverly Strother. Civ. and Min. Engr., Berkeley Springs, W. Va.		May 2, 1888
Randolph, Isham. Cons. Engr., 748 First National Bank Bldg., Chicago, Ill.		Feb. 4, 1903
Randolph, Lingan Strother. Prof., Mech. Eng., Virginia Polytechnic Inst., Blacksburg, Va.		Jan. 2, 1890
Ray, Frederick George. Prin. Asst. Engr., U. S. Lake Survey, 33 Campau Bldg., Detroit, Mich.		April 6, 1909
Ray, George Joseph. Chf. Engr., D., L. & W. R. R., Hoboken (Res., East Orange), N. J.		June 3, 1908
Raymond, Charles Walker. Brig.-Gen., U. S. A. (*Retired*), Water Witch Club, Highlands, N. J.		June 1, 1893
Raymond, Charles Ward. 816½ K St., Sacramento, Cal.	Jun. M.	Nov. 7, 188 April 7, 1880
Raymond, William Galt. Prof., Civ. Engr.; Dean, Coll. of Applied Science, State Univ. of Iowa; Cons. Civ. Engr., Iowa City, Iowa		Oct. 3, 1894
Rea, Samuel. Third Vice-Pres., P. R. R. Co., 225 Broad St. Station, Philadelphia, Pa.		June 4, 1884
Reaburn, De Witt Lee. Div. Engr., Los Angeles Aqueduct, Surrey, Cal.	Assoc. M. M.	April 6, 1904 Nov. 30, 1909
Read, Robert Leland. 68 Summer St., Malden, Mass.		Sept. 2. 1874
Reber, Henry Linton. Gen. Mgr., Kinloch Telephone Co., Kinloch Bldg., St. Louis, Mo.		May 4, 1904
Redlich, Carl. Civ. Engr. and Contr., IX Garnisongasse 3, Vienna, Austria		Sept. 7, 1904

		Date of Membership.
REED, DAVID ABELL. Div. Engr., Wisconsin Central Ry., 422 Lyceum Bldg., Duluth, Minn		Mar. 4, 1896
REED, MELVILLE EMERSON. Engr., U. S. Reclamation Service, Huntley Project, Huntley, Mont		Mar. 6, 1901
REED, PAUL LYON. Civ. Engr., U. S. N., Navy Yard, Puget Sound, Bremerton, Wash		July 9, 1906
REED, WENDELL MONROE. Dist. Engr., Texas and New Mexico, U. S. Reclamation Service, El Paso, Tex		Oct. 5, 1904
REED, WILLIAM BOARDMAN. Pres., O. & H. R. R. Co., 420 East 25th St., New York City	Assoc. M. M.	Feb. 6, 1895 May 1, 1901
REEVES, DAVID. Pres., The Phœnix Iron Co.; Pres., Phœnix Bridge Co., 410 Walnut St., Philadelphia, Pa	Jun. M.	April 1, 1874 May 3, 1882
REEVES, HARLEY EDSON. U. S. Junior Engr., Atkinson, Ill		Jan. 4, 1910
REICHMANN, ALBERT FERDINAND. Res. Engr., Am. Bridge Co., 1305 Commercial National Bank Bldg., Chicago, Ill	Jun. Assoc. M. M.	April 30, 1895 Oct. 5, 1898 Mar. 4, 1903
REIMER, WILLIAM HENRI VALE. 28 N. Maple Ave., East Orange, N. J		Mar. 6, 1907
RENSHAW, ALFRED HOWARD. Noroton, Conn		June 1, 1898
REYNDERS, JOHN VAN WICHEREN. Vice-Pres., The Pennsylvania Steel Co., Steelton, Pa	Assoc. M. M.	June 1, 1892 Mar. 3, 1897
REYNOLDS, ABRAHAM MOREAU. Engr. and Supt., Essex Co. Park Comm., 60 Clifton Ave., Newark, N. J		Nov. 30, 1909
RHINES, GEORGE VOLNEY. Structural Engr. with Geo. S. Mills, Archt., 1234 Ohio Bldg., Toledo, Ohio	Assoc. M. M.	June 3, 1903 Feb. 1, 1910
RIBLET, BYRON CHRISTIAN. Care, Bank of Montreal, Spokane, Wash		July 1, 1908
RICE, GEORGE STAPLES. Engr. of Subway Constr., Public Service Comm. for 1st Dist., 154 Nassau St., New York City		Feb. 1, 1882
RICE, WALTER PERCIVAL. Civ. and Cons. Engr. (The Walter P. Rice Eng. Co.), Society for Savings, Cleveland, Ohio		Mar. 6, 1889
RICH, EDWARD DUNBAR. Asst. Prof. in Civ. Eng., Univ. of Michigan (Res., 929 Church St.), Ann Arbor, Mich		Nov. 4, 1908
RICH, ISAAC. Asst. Engr., N. Y., N. H. & H. R. R., Room 469, South Station, Boston, Mass		May 6, 1903
RICHARDS, ALBERT LENNOX. U. S. Asst. Engr., Care, U. S. Engrs. Office, Rock Island, Ill		Jan. 2, 1901
RICHARDS, JOSEPH THOMAS. Chf. Engr., M. of W., P. R. R. Co., Broad St. Station, Philadelphia, Pa		April 4, 1894
RICHARDSON, CLIFFORD. Proprietor, New York Testing Laboratory (Maurer, N. J.), Room 1826, 30 Church St. (Res., 122 East 34th St.), New York City	Assoc. M.	Oct. 4, 1892 Feb. 4, 1908

		Date of Membership.
Richardson, Thomas Franklin. Chf. Civ. Engr., J. G. White & Co., Inc., 43 Exchange Pl., New York City		Nov. 4, 1885
Ricker, George Alfred. 702 Ellicott Sq., Buffalo, N. Y.	Jun. Assoc. M. M.	April 7, 1886 May 1, 1895 April 3, 1901
Ricketts, Louis Davidson. Cananea, Sonora, Mexico		Oct. 5, 1904
Ricketts, Palmer Chamberlaine. Pres. of, and Prof. of Mechanics, Rensselaer Polytechnic Inst., Troy, N. Y.	Assoc. M.	Feb. 3, 1886 Oct. 5, 1887
Rickey, James Walter. Chf. Engr., Long Sault Development Co., Massena, N. Y.	Assoc. M. M.	Sept. 3, 1902 April 4, 1905
Rickon, Frederic John Henry. Rickon-Ehrhart Eng. & Constr. Co., 1859 Geary St., San Francisco, Cal.		Jan. 4, 1888
Ridgway, Robert. Dept. Engr., Board of Water Supply of the City of New York, 236 Main St., Poughkeepsie, N. Y.	Jun. M.	Feb. 1, 1888 June 3, 1903
Riegner, Wallace Berkley. Engr. of Bridges, P. & R. Ry., Reading Terminal, Philadelphia, Pa.		Sept. 7, 1904
Riffle, Franklin. Mgr., Iron and Pipe Depts., Dunham, Carrigan & Hayden Co., 130 Kansas St., San Francisco, Cal.		Nov. 7, 1888
Riggs, Henry Earle. (The Riggs & Sherman Co., Cons. Engrs.), 613 Nasby Bldg., Toledo, Ohio	Assoc. M. M.	Oct. 4, 1893 April 1, 1896
Riggs, Morris John. Mgr., Toledo Plant, Am. Bridge Co., Toledo, Ohio		Dec. 6, 1899
Righter, Addison Alexander. Engr., Chicago Harbor Comm., 519 The Rookery, Chicago, Ill.		Jan. 4, 1910
Rights, Lewis Daniel. Contr. Mgr., Lewis F. Shoemaker & Co., 45 Broadway, New York City	Assoc. M. M.	Mar. 5, 1902 Sept. 1, 1908
Ripley, Henry Clay. Civ. and Cons. Engr., 58 Avenida Central, Rio de Janeiro, Brazil		Oct. 7, 1896
Ripley, Herbert Lawrence. Engr., Constr., N. Y., N. H. & H. R. R., New Haven (Res., 542 Washington Ave., West Haven), Conn.		Oct. 7, 1908
Ripley, John Wesley. Secy. and Treas., The Robbins-Ripley Co., 50 Church St., New York City		May 1, 1907
Ripley, Joseph. Member, Advisory Board of Engrs. for State Canals, State Hall, Albany, N. Y.		Sept. 4, 1901
Rippey, Samuel Howard. Cons. Engr., Stephen Girard Bldg., Philadelphia (Res., Upsal St., west of Wayne Ave., Germantown), Pa.		May 6, 1908
Riser, Knud Sophus. Cons. Civ. and Architectural Engr., 615 The Gilbert, Grand Rapids, Mich.		Feb. 3, 1892
Ritchie, George Alexander. Hotel Metropolitano, Bogota, Colombia		May 6, 1908

		Date of Membership.
Ritchie, James. Civ. and Cons. Engr., 516 Electric Bldg., Cleveland, Ohio		Nov. 5, 1890
Rittenhouse, Walter Britton. Paonia, Colo.		April 6, 1909
Ritter, Louis E. (Ritter & Mott), 1433 Marquette Bldg., Chicago, Ill.		Oct. 4, 1905
Rix, Edward Austin. Pneumatic Engr.; Pres., Rix Compressed Air & Drill Co., 219 Spear St., San Francisco, Cal.		April 7, 1897
Robbins, Allan Appleton. Pres., Robbins-Ripley Co., 50 Church St., New York City	Assoc. M. M.	Oct. 2, 1901 Sept. 6, 1904
Robbins, Samuel Bostwick. Engr. in Chg., Sun River Project, U. S. Reclamation Service, Fort Shaw, Mont.		Sept. 6, 1905
Roberts, Evelyn Pierrepont. Civ. and Cons. Engr., 18 Broadway, New York City		May 7, 1884
Roberts, George Thomas. Contr., 401 D. S. Morgan Bldg., Buffalo, N. Y.	Assoc. M. M.	Sept. 3, 1902 Mar. 3, 1908
ROBERTS, PERCIVAL, Jr. (*Director*). 717 Arcade Bldg., Philadelphia, Pa.	Assoc. M.	May 7, 1879 June 4, 1884
Roberts, Shelby Saufley. Asst. Prof., Railway Civ. Eng., Univ. of Illinois (Res., 1018 W. Nevada St.), Urbana, Ill.	Assoc. M. M.	April 5, 1905 Jan. 7, 1908
Roberts, William Jackson. Cons. Engr., Medford, Ore.	Assoc. M. M.	June 6, 1900 Sept. 3, 1907
Robertson, Marshall Pope. Member, State Board of Engrs. of La., 225 Carondelet St., New Orleans, La.	Assoc. M. M.	Mar. 5, 1902 Sept. 4, 1906
Robinson, Albert Alonzo. 900 Tyler St., Topeka, Kans.		May 5, 1880
Robinson, Albert Fowler. Bridge Engr., A., T. & S. F. Ry. System, 1000 Railway Exchange Bldg., Chicago, Ill.		Nov. 2, 1887
Robinson, Arthur Wells. 14 Phillips Sq., Montreal, Que., Canada		Feb. 3, 1892
Robinson, Erdis Geroska. Secy.-Treas., S. W. Robinson & Son Co., 515 West First Ave. (Res., 355 West Ninth Ave.), Columbus, Ohio		Mar. 2, 1909
Robinson, Stillman Williams. Prof. Emeritus in Mech. Eng., Ohio State Univ., 1353 Highland St., Columbus, Ohio		Jan. 2, 1884
Rockwell, James Vincent. Civ. Engr., U. S. N.; Inspecting Engr. for U. S. Navy, Gen. Elec. Co., Schenectady, N. Y.	Jun. Assoc. M. M.	April 3, 1900 Feb. 4, 1903 Nov. 5, 1907
Rockwell, Samuel. Chf. Engr., L. S. & M. S. Ry. Co., Cleveland, Ohio		Jan. 7, 1880
Rockwood, Arthur Jones. Cons. Engr. and Contr., 407 Cutler Bldg., Rochester, N. Y.		Feb. 1, 1905
Rodd, Thomas. Chf. Engr., Penn. Lines W. of Pitts., Union Station, Pittsburg, Pa.		June 5, 1878
Rogers, Edwin Henry. City Engr. of Newton, City Hall, West Newton, Mass.		Jan. 2, 1907

		Date of Membership.
ROGERS, GEORGE HAMILTON. 5 East 42d St., New York City		July 1, 1909
ROGERS, WALTER ALEXANDER. Pres., Bates & Rogers Constr. Co., 355 Dearborn St., Chicago, Ill	Jun. Assoc. M. M.	Sept. 10, 1891 Nov. 3, 1897 April 4, 1900
ROHRER, GRANT. Contr., 299 Broadway, New York City		July 1, 1909
ROHRER, JACOB BOMBERGER. Civ. Engr. and Contr., 336 North Duke St., Lancaster, Pa		Nov. 6, 1907
ROHWER, HENRY. Cons. Engr., 901 New National Bank of Commerce Bldg. (Res., 5646 Cates Ave.), St. Louis, Mo		April 1, 1903
ROLLINS, JAMES WINGATE, JR. Pres., Holbrook, Cabot & Rollins Corporation, Contrs., 922 Beacon Bldg., Boston, Mass.		Nov. 7, 1900
ROMMEL, GEORGE, JR. Pensacola, Fla	Jun. Assoc. M. M.	Jan. 3, 1899 Mar. 5, 1902 Oct. 2, 1906
ROOD, HENRY MARTYN. 163 William St., Port Chester, N. Y.		Dec. 3, 1890
ROPES, HORACE. 11 Chestnut Pl., Brookline, Mass		Sept. 2, 1903
ROSE, CHARLES CLEMONS. Supt., Coal Dept., The D. & H. Co., Scranton, Pa		April 4, 1888
ROSENBERG, THEODORE. Cons. Engr. and Archt., Glenwood Springs, Colo		Jan. 4, 1910
ROSENCRANS, EDWIN JOHN. Archt. (Jackson & Rosencrans), 1328 Broadway, New York City		May 7, 1902
ROSENCRANS, WILLIAM HENRY. Chf. Engr., Hydro-Electric Dept., The Arnold Co., 181 La Salle St., Chicago, Ill		Oct. 5, 1898
ROSS, ALEXANDER BELL. Representative, Missouri Val. Bridge & Iron Co. of Leavenworth, Kans., City of Mexico, Mexico.		May 2, 1900
ROSS, DOUGLAS WILLIAM. Chf. Engr., Sacramento Val. Irrig. Co., Willows, Cal		Mar. 1, 1899
ROSS, ELMER WAYLAND. Asst. Engr., Bridge Dept., City Engr.'s Office, Providence, R. I.	Jun. Assoc. M. M.	Mar. 5, 1890 June 1, 1892 April 3, 1906
ROSS, FLORIAN GAIE. Civ. and Cons. Engr., 307 Fifth Ave., Pittsburg, Pa		Dec. 2, 1903
ROSS, JAMES. 112 St. James St., Montreal, Que., Canada		Sept. 6, 1882
ROTCH, WILLIAM. 131 State St., Boston, Mass		Mar. 5, 1873
ROURKE, LOUIS KEEGAN. Asst. Div. Engr., Central Div., Isthmian Canal Comm., Empire, Canal Zone, Panama		July 1, 1909
R. ROWE, SAMUEL MCMATH. Cons. Engr., 364 Monadnock Bldg., Chicago, Ill		Sept. 2, 1885
ROWELL, GEORGE FREEMAN. Res. Engr., Chattanooga & Tennessee River Power Co., Guild, Tenn	Jun. Assoc. M. M.	May 4, 1897 Mar. 5, 1901 Jan. 4, 1910
ROWLAND, CHARLES BRADLEY. Vice-Pres., The Continental Iron Works, West and Calyer Sts., Brooklyn, N. Y.		May 1, 1895
ROWLAND, CHARLES LEONARD. Pres., Am. Welding Co., Carbondale, Pa		Sept. 1, 1886

		Date of Membership.
Rowland, Thomas Fitch, Jr. Pres., The Continental Iron Works, West and Calyer Sts., Brooklyn, N. Y.		Sept. 1, 1886
Rowse, Albert Owen. Asst. U. S. Engr., 208 West 7th St., Sterling, Ill.		Mar. 4, 1908
Roy, Robert Maitland. Mgr. and Asst. to Pres., The Hamilton Bridge Works Co., Ltd., Hamilton, Ont., Canada	Assoc. M. M.	Oct. 3, 1900 Mar. 5, 1907
Ruddle, John. Mauch Chunk, Pa.		Oct. 3, 1894
Ruggles, William Burroughs. Chf. Engr., Alaska Central Ry. Co., Seward, Alaska		April 7, 1886
Rundlett, Leonard W. Commr. of Public Works, St. Paul, Minn.		Sept. 5, 1883
Ruple, Commodore Perry. Secy. and Treas., The C. H. Fath & Son Constr. Co., 516 Electric Bldg., Cleveland, Ohio		Mar. 5, 1902
Rushmore, David Barker. Chf. Engr., Power and Min. Dept., Gen. Elec. Co., Schenectady, N. Y.		Jan. 2, 1907
Russell, Richard Lord. Chf. Engr., Chas. Cranford; Chf. Engr., Borough Development Co., 186 Remsen St., Brooklyn, N. Y.	Jun. Assoc. M. M.	Feb. 5, 1895 April 3, 1901 Sept. 4. 1906
Russell, Samuel Moorhead. Supt., Tol., Peoria & West. Ry. Co., Union Station, Peoria, Ill.		Sept. 6. 1905
Russell, Silas Bent. Cons. Civ. Engr., Security Bldg., St. Louis, Mo.	Jun. M.	June 4, 1884 June 1, 1887
Russell, William Gardner. Altura, El Paso Co., Tex.		Oct. 4, 1905
Rust, Charles Henry. City Engr.'s Dept., Toronto, Ont., Canada		April 5, 1899
Rust, Henry Bedinger. Care, The Babcock & Wilcox Co., 1110 Farmers Bank Bldg. (Res., 1177 Murray Hill Ave.), Pittsburg, Pa.	Assoc. M. M.	April 6, 1898 April 1, 1903
Ruttan, Henry Norlande. City Engr., Winnipeg, Man., Canada		Jan. 4, 1893
Ryder, Ely Morgan Talcott. Engr., M. of W., Third Ave. R. R. Co., 130th St. and Third Ave., New York City	Jun. M.	Jan. 5, 1897 Dec. 5, 1906
Sabin, Alpheus Timothy. 804 Borland Bldg., Chicago, Ill.		April 1, 1896
Sabin, Louis Carlton. Gen. Supt., St. Marys Falls Canal, Sault Ste. Marie, Mich.	Assoc. M. M.	Oct. 4, 1893 May 7, 1902
Sackett, John Warren. Chf. Asst. Engr., U. S. Engr. Office, Jacksonville, Fla.		May 2, 1894
Safford, Arthur Truman. Asst. Engr., Proprietors of Locks and Canals, 66 Broadway, Lowell, Mass.		Sept. 6, 1899
Safford, Edward Stanley. Civ. and Cons. Engr., Sharon, Mass.		Dec. 6, 1882
Safford, Harry Robinson. Chf. Engr., M. of W., Ill. Cent. R. R. Co., 1 Park Row, Chicago, Ill.		July 1, 1908

		Date of Membership.
Safford, Vinton Putnam. Mgr., Mex. North. Ry., Escalon, Chihuahua, Mexico		July 4, 1894
Sample, John Henderson. 4904 Cedar Ave., Cleveland, Ohio.		Oct. 6, 1886
Sanborn, Frank Berry. Prof of Civ. Eng., Tufts Coll., Tufts College, Mass		Oct. 1, 1902
Sanders, William Horatio. Cons. Engr., U. S. Reclamation Service, 915 Grand View Ave., Los Angeles, Cal		Feb. 3, 1904
Sando, Will Joseph. Mgr., Pumping Engine and Hydr. Turbine Dept., Allis-Chalmers Co., Milwaukee, Wis		Aug. 31, 1909
Sapp, Edward Howard. Civ. Engr., New York Shipbuilding Co., Camden (Res., Wenonah), N. J		Sept. 6, 1905
Sarle, Oliver Perry. 146 Westminster St., Providence, R. I.		Jan. 2, 1901
Saunders, William Lawrence. Pres., Ingersoll-Rand Co.; Editor, *Compressed Air*, 11 Broadway, New York City		Nov. 3, 1886
Savage, Hiram Newton. Superv. Engr., Dept. of the Interior, U. S. Reclamation Service, Washington, D. C.; Address, Helena, Mont.	Assoc. M. M.	Mar. 7, 1894 Oct. 7, 1896
Savage, John Richard. Chf. Engr., L. I. R. R. Co., Jamaica, N. Y		June 7, 1905
Saville, Caleb Mills. In Chg., Third Div., Office of Chairman and Chf. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama.	Assoc. M. M.	Nov. 6, 1895 Jan. 2, 1901
Sawyer, Edward. 100 Bellevue St., Newton, Mass		Oct. 2, 1895
Sawyer, Walter Howard. Hydr. Engr. and Agt., Union Water Power Co., 11 Lisbon St., Lewiston, Me		May 2, 1906
Sax, Percival Mosley. 1328 Chestnut St., Philadelphia, Pa	Jun. Assoc. M. M.	Jan. 31, 1893 Jan. 3, 1900 April 3, 1901
Sayles, Earle Willoughby. City Engr., Watertown, N. Y		June 1, 1909
Sayles, Robert Wilson. Prin. Asst. Engr. with Chas. W. Leavitt, Jr., 220 Broadway, New York City	Assoc. M. M.	April 5, 1905 May 5, 1908
Scaife, William Lucien. Chairman, Scaife Foundry & Machine Co., Ltd., 28th St., Pittsburg, Pa		Dec. 3, 1890
Scarborough, Francis Winthrop. Engr. and Archt. (Scarborough & Howell, Inc.), 723 E. Main St., Richmond, Va	Jun. Assoc. M. M.	Sept. 3, 1890 Mar. 6, 1895 Feb. 2, 1904
Schaeffer, Amos. Care, Gore-Meenan Co., 149 Broadway, New York City	Assoc. M. M.	Feb. 3, 1904 Feb. 6, 1906
Schall, Frederick Edward. Bridge Engr., Lehigh Val. R. R., South Bethlehem, Pa		Oct. 1, 1902
Scherer, Clinton Lyter. City Engr., Beaumont, Tex		Nov. 8, 1909
Schlecht, Walter William. Care, U. S. Reclamation Service, Orland, Cal		April 6, 1909
Schmidt, Max Eberhardt. Pres. and Chf. Engr., Continuous Transit Securities Co., 45 Broadway, New York City		May 7, 1879

		Date of Membership.
Schnauber, Frank Justus. 516 Kirk Bldg., Syracuse, N. Y. .		Mar. 6, 1907
Schneeweiss, Adolph Eugene. Engr., John W. Ferguson Co., Paterson, N. J.		Oct. 5, 1909
. **SCHNEIDER, CHARLES CONRAD.** (*Past-President*). Cons. Engr., Pennsylvania Bldg., Philadelphia, Pa.		Feb. 6, 1884
Schneider, Edward John. Contr. Mgr., Am. Bridge Co. of New York, 906 Crocker Bldg., San Francisco, Cal.	Assoc. M.	July 9, 1906 Nov. 8, 1909
Schofield, Hiram Abif. Dist. Mgr., Pittsburg Testing Laboratory, Ltd., Room 906, Crozer Bldg., Philadelphia, Pa. .		Oct. 7, 1896
Schreiber, John Martin. Engr., M. of W., Public Service Ry. Co., 7 Central Ave., Newark, N. J.	Assoc. M. M.	June 5, 1907 Nov. 30, 1909
Schroeder, Christoffer. Architectural Engr. with C. Frank Jobson, Archt. for the Pullman Co., 415 Pullman Bldg. (Res., 6509 LaFayette Ave.), Chicago, Ill.		June 1, 1909
Schubert, Frederick Celestine. U. S. Asst. Engr., Custom House, Portland, Ore.	Assoc. M. M.	June 5, 1907 Feb. 2, 1909
Schultz, Albert Louis. 817 North Highland Ave., Pittsburg, Pa.		Sept. 4, 1901
Schultze, Paul. County Supt. of Highways, Oneida Co., Utica, N. Y.	Assoc. M. M.	Nov. 2, 1898 June 5, 1901
Schulze, Henry Atherton. 512 East 17th St., East Oakland, Cal.		Oct. 2, 1907
. **Schuyler, James Dix.** Cons. Engr., Suite 1115, Union Trust Bldg., Los Angeles, Cal.		Dec. 6, 1882
Schwitzer, John Edward. Asst. Chf. Engr., Lines West of Port Arthur, Canadian Pac. Ry. Co., Winnipeg, Man., Canada		July 10, 1907
Scofield, Edson Mason. Pres., Scofield Eng. Co., Philadelphia, Pa.	Assoc. M. M.	April 1, 1896 May 2, 1905
Scofield, Glenn Mason. Cons. Engr., 906 Pennsylvania Bldg., Philadelphia, Pa.		Sept. 7, 1904
Scorgie, James Cruickshank. Supt., Mount Auburn Cemetery, Cambridge, Mass.		Nov. 4, 1908
Scott, Addison Moffat. Charleston, Kanawha Co., W. Va. . .		June 2, 1886
Scott, Ernest Kay. Care, Hoover & Mason, 1407 Railway Exchange, Chicago, Ill.		Mar. 2, 1898
Scotten, Frank. Supt., Constr. Dept., Great Falls Water Power & Townsite Co., Great Falls, Mont.		Aug. 31, 1909
Scovill, Edward Tracy. Dansville, N. Y.		Sept. 6, 1876
Scripture, Arthur Marquis. New Hartford, N. Y.	Assoc. M. M.	June 3, 1896 Jan. 5, 1904
Seaman, Henry Bowman. Chf. Engr., Public Service Comm., 154 Nassau St., New York City	Jun. M.	June 2, 1886 Dec. 7, 1887
Searles, William Henry. Cons. Civ. Engr., Elyria, Ohio. . .		July 2, 1873

			Date of Membership.
	SEARS, ALFRED FRANCIS. Portland, Ore		June 2, 1869
	SEARS, WALTER HERBERT. 220 Sandwich St., Plymouth, Mass.		Oct. 5, 1904
	SEAVER, JOHN WRIGHT. Cons. Engr., Caxton Bldg., Cleveland, Ohio		Nov. 6, 1901
N.	SEDDON, JAMES ALEXANDER. Address unknown		Nov. 2, 1898
	SELANDER, JOHN EINAR. Care, Baker & Shelford, Cons. Engrs., Westminster, London, England		Nov. 4, 1908
	SELLEW, FRANCIS LIBBY. Project Engr., U. S. Reclamation Service, Yuma, Ariz	Assoc. M. M.	Dec. 5, 1906 July 1, 1909
	SELTZER, HARRY KENT. Engr. of Constr., Union Bridge & Constr. Co., 903 Sharp Bldg., Kansas City, Mo	Jun. Assoc. M. M.	Feb. 4, 1896 Jan. 2, 1901 April 3, 1906
	SENGOKU, MITSUGU. 21 Fujimicho Azabu, Tokyo, Japan		June 4, 1890
	SERBER, DAVID CHARLES. Structural Engr., Henry Steers, Inc., 17 Battery Pl., New York City		April 6, 1909
	SERGEANT, GEORGE, JR. 501 West 113th St., New York City.		April 2, 1902
	SEUROT, PAUL ALBERT. 5 Rue Chambiges, Paris, France	Jun. Assoc. M. M.	April 30, 1895 Oct. 4, 1899 Nov. 1, 1904
N.	SEWELL, JOHN STEPHEN. Vice-Pres. and Gen. Mgr., Alabama Marble Co., Gantts Quarry, Ala		April 5, 1905
	SHAILER, ROBERT AMES. Cons. Engr., 101 Tremont St., Room 304, Boston, Mass		Mar. 3, 1880
	SHAND, GADSDEN EDWARDS. 1831 Pendleton St., Columbia, S. C		Nov. 7, 1906
	SHAND, JAMES. Obras del Puerto, Salina Cruz, Oaxaca, Mexico		Oct. 2, 1907
	SHANKLAND, EDWARD CLAPP. (E. C. & R. M. Shankland), 1106 Rookery, Chicago, Ill		Feb. 5, 1890
	SHANKLAND, RALPH MARTIN. 1106 Rookery Bldg., Chicago, Ill.		Mar. 1, 1899
	SHANKS, OSCAR. Care, Ball Eng. Co., Praetorian Bldg., Dallas, Tex		July 9, 1906
	SHANLY, JAMES MOORE. Contr. Engr., 346 Prince Arthur St., Montreal, Que., Canada		July 6, 1887
	SHANNAHAN, JOHN NEWTON. Vice-Pres. and Gen. Mgr., Washington, Baltimore & Annapolis Elec. Ry. Co., Baltimore, Md	Jun. Assoc. M. M.	Oct. 4, 1898 Mar. 6, 1901 May 5, 1908
	SHATTUCK, ORVILLE FRANK. City Engr., Greeley, Colo		July 1, 1908
	SHAW, ENOS LARKIN. 1105 Monadnock Blk., Chicago, Ill	Jun. Assoc. M. M.	Oct. 3, 1893 June 1, 1898 Mar. 6, 1906
	SHAW, GRANVILLE WHEATON. U. S. Asst. Engr., P. O. Box 496, Louisville, Ky		Oct. 5, 1887
	SHAW, SUMNER FARNHAM. Chf. Engr., Cuba R. R., Camagüey, Cuba		Oct. 3, 1894

		Date of Membership.
Sheal, Robert Erwin. Engr., Care, The Wellman-Seaver-Morgan Co., Cor. Central and Giddings Ave., Cleveland, Ohio		Oct. 4, 1905
Shearwood, Frederick Perry. Dominion Bridge Co., Montreal, Que., Canada		Oct. 7, 1903
Shedd, Edward Whitten. Civ. and Hydr. Engr., Providence, R. I.		May 6, 1903
Shedd, Frank Edson. Vice-Pres. and Chf. Engr., Lockwood, Greene & Co., 93 Federal St., Boston, Mass		Feb. 6, 1907
Shedd, Joel Herbert. Cons. Engr., Providence, R. I.		Sept. 15, 1869
Shenehon, Francis Clinton. Dean, Coll. of Eng., Univ. of Minnesota, Minneapolis, Minn		May 7, 1902
Shepard, David Chauncey. 324 Dayton Ave., St. Paul, Minn.		May 2, 1883
Shepard, Henry Hudson. Supt., D., L. & W. R. R., Scranton, Pa		Feb. 5, 1908
Shepherd, Frank Cummings. Constr. Supt., J. G. White & Co., Inc., Jackson, Ga	Assoc. M. M.	Oct. 5, 1904 Feb. 1, 1910
Sheppard, Charles Alfred. 115 Purcell St., Edwardsville, Ill.		Nov. 30, 1909
Sherman, Charles Winslow. Prin. Asst. Engr. with Metcalf & Eddy, Cons. Engrs., 14 Beacon St., Boston, Mass	Jun. Assoc. M. M.	Oct. 8, 1891 May 2, 1900 Feb. 4, 1903
Sherman, Herbert Ellwood. Asst. Engr. in Chg. of Dept. of Street Lines, City Engr.'s Office, Providence, R. I.		Mar. 7, 1900
Sherman, Richard Willette. Pres., Troy Public Works Co., Utica, N. Y.		Oct. 6, 1886
Sherman, Walter Justin. (The Riggs and Sherman Co., Cons. Engrs.), 613 Nasby Bldg., Toledo, Ohio		May 4, 1909
Sherrerd, John Maxwell. Gen. Sales Agt., Taylor Iron & Steel Co., 340 Spring Garden St., Easton, Pa		July 10, 1907
Sherrerd, Morris Robeson. Chf. Engr., Dept. of Public Works, City Hall, Newark, N. J.	Assoc. M. M.	May 3, 1893 May 6, 1896
Shiraishi, Naoji. Care, Branch Office, Mitsu Bishi Co., Kobe, Japan		Oct. 4, 1899
Shmeleff, Theodor Semenovitch. Engr., Russian Imperial Civil Service, Novorossiisk, Caucasus, Russia		Sept. 7, 1892
Shuman, Edward Peter. Div. Engr., Bureau of Public Works, Manila, Philippine Islands		Oct. 2, 1907
Sibert, William Luther. Maj., Corps of Engrs., U. S. A.; Supervisory Engr., Dept. of Constr. and Eng., Isthmian Canal Comm., Culebra, Canal Zone, Panama		June 2, 1897
Silva Freire, Victor da. City Chf. Engr.; Prof., Polytechnic School, P. O. Box 18, São Paulo, Brazil		Jan. 3, 1906
Simpson, George Frederic. Asst. Engr., Rapid Transit R. R. Comm., 520 West 145th St., New York City		Mar. 2, 1887
Simpson, George Hume. 434 Shady Ave., Pittsburg, Pa.		Oct. 6, 1880
Sims, Alfred Varley. Pres. and Gen. Mgr., Cuba Eastern R. R. and Allied Cos., Guantanamo, Cuba		Mar. 4, 1896

		Date of Membership.
Sims, Clifford Stanley. Second Vice-Pres. and Gen Mgr., Delaware & Hudson Co., Albany, N. Y.		April 1, 1903
Simson, David. Ickleford Manor, Hitchin, Herts, England		Jan. 8, 1902
Sinclair, Frank Oscar. Cons. Engr. for Public Service Comm. of Vermont, Burlington, Vt.		Nov. 6, 1901
Sinks, Frank Forrest. (Condron & Sinks, Cons. Engrs.), 1214 Monadnock Bldg., Chicago, Ill.	Assoc. M. M.	May 2, 1906 June 4, 1907
Sirrine, Joseph Emory. Box 581, Greenville, S. C.	Jun. Assoc. M. M.	June 20, 1893 May 4, 1898 May 6, 1903
Sjöström, Ivar Ludwig. Vice-Pres., United States Worsted Co., Lawrence, Mass.	Jun. M.	Sept. 6, 1892 Sept. 1, 1897
Skilton, George Steele. Asst. Engr., Dept. of Water Supply, Gas and Electricity of City of New York, Borough of Brooklyn (Res., Rockville Centre), N. Y.		Sept. 7, 1881
Skinner, Frank Woodward. Associate Editor, *The Engineering Record*, 239 West 39th St., New York City		Sept. 1, 1886
Skinner, John Franklin. Prin. Asst. to City Engr., 52 City Hall (Res., 31 Somerset St.), Rochester, N. Y.		April 4, 1906
Slifer, Hiram Joseph. Gen. Mgr., Chic. Gt. West. R. R., 512 Harvester Bldg., Chicago, Ill.		June 5, 1907
Sloan, David. Chf. Engr., MacArthur Bros. Co., Contrs., 810 Fisher Bldg., Chicago, Ill.		Jan. 1, 1896
Sloan, William Griffith. Eastern Mgr., MacArthur Bros. Co., 11 Pine St., New York City		Dec. 1, 1908
Slocum, Charles Mills. City Engr., 43 Bridge St., Springfield, Mass.		May 5, 1897
Smead, Raphael Chart. U. S. Asst. Engr., Federal Bldg., Dallas, Tex.		Feb. 1, 1905
Smith, Albert Mather. Engr. of Distrib., Consolidated Gas Co. of New York, 4 Irving Pl., New York City		May 5, 1886
Smith, Augustus. Engr. and Contr., 149 Broadway, New York City		June 4, 1902
Smith, Cecil Brunswick. Cons. Engr. (Smith, Kerry & Chace), Toronto, Ont., Canada		Mar. 1, 1905
Smith, Charles William. 393 Lewis Ave., Brooklyn, N. Y.	Assoc. M. M.	April 5, 1893 Dec. 1, 1903
Smith, Edwin Foster. 4102 Locust St., Philadelphia, Pa.		June 5, 1895
Smith, Eugene Raymond. Islip, Suffolk Co., N. Y.	Jun. M.	May 2, 1888 May 1, 1901
Smith, Francis Betts. Care, Scofield Constr. Co., Mare Island, Cal.		Jan. 2, 1907
Smith, Francis Pitt. Chemical & Cons. Paving Engr. (Dow & Smith), 24 East 21st St., New York City		Nov. 30, 1909

		Date of Membership.
Smith, Gilman Walter. Div. Erecting Mgr., Am. Bridge Co. of New York, 1332 Commercial National Bank Bldg., Chicago, Ill.		Mar. 2, 1909
Smith, Henry Clement. Div. Engr., Phila. Div., P. & R. Ry., Philadelphia, Pa.		Oct. 2, 1901
Smith, Henry DeWitt. Res. Engr., T. & F. S. Ry. Co., Texarkana, Ark.-Tex.		Dec. 6, 1893
Smith, Howard Everett. Res. Engr., N. Y. State Dept. of Highways, Griffin Bldg., Syracuse, N. Y.		Nov. 6, 1907
Smith, James. Care, Bengal Iron & Steel Co., Ltd., Manharpur, B. N. R., Bengal, India	Assoc. M. M.	Nov. 1, 1905 Mar. 31, 1908
Smith, John Herman. 3414 Wayne Ave., Kansas City, Mo.		Nov. 7, 1906
Smith, Jonas Waldo. Chf. Engr., Board of Water Supply of the City of New York, 299 Broadway, New York City	Assoc. M. M.	Oct. 5, 1892 April 5, 1899
Smith, Joseph Shuter. Care, Robt. S. Perry, 5104 Pulaski Ave., Germantown, Philadelphia, Pa.		April 1, 1874
Smith, Leonard Charles Lindsay. Asst. Engr., Dept. of Water Supply, Gas and Electricity, 59 Woolsey St., Long Island City, N. Y.		Mar. 6, 1901
Smith, Merritt Haviland. Dept. Engr., Board of Water Supply, City of New York, Realty Bldg. (Res., Waller Homestead), White Plains, N. Y.	Jun. M.	June 5, 1889 April 3, 1907
Smith, Miller Armstrong. Cons. and Contr. Engr. (Smith & Davis), 512 Lonja Bldg., Havana, Cuba		Oct. 6, 1886
Smith, Oberlin. Pres., Ferracute Machine Co., "Lochwold," Bridgeton, N. J.		Sept. 3, 1884
Smith, Robert Colfax. 1106 The Rookery, Chicago, Ill.		July 9, 1906
Smith, Stewart Kedzie. Gen. Mgr., Vinton Colliery Co., Vintondale, Pa.		April 6, 1904
Smith, T. Guilford. Mgr. of Sales, Carnegie Steel Co., Illinois Steel Co., U. S. Steel Products Export Co., Tennessee Coal, Iron & R. R. Co., 203 Ellicott Sq., Buffalo, N. Y.		Sept. 6, 1871
Smith, Walter Mickle. Designing Engr., Board of Water Supply, 299 Broadway, New York City	Assoc. M. M.	Oct. 2, 1901 April 3, 1906
Smith, William Charles. Chf. Engr., I. & W. N. R. R., Spirit Lake, Idaho		Sept. 4, 1901
Smith, William Sooy. Riverside, Ill.		Jan. 17, 1872
Smith, Willis Roswell. Res. Engr. for The Arnold Co. of Chicago, Laramie, Wyo.		Mar. 4, 1908
Smoot, Edgar Kenneth. Concessionario, Obras del Puerto de Manzanillo, Manzanillo, Mexico		Feb. 2, 1898
Snell, Thomas Cullen Bryant. Structural Engr., National Board of Fire Underwriters, New York City; Address, 464 Whalley Ave., New Haven, Conn.		July 10, 1907

		Date of Membership.
Snook, Thomas Edward. 73 Nassau St., New York City		Mar. 3, 1897
Snow, Charles Henry. Dean, School of Applied Science, New York Univ., New York City	Assoc. M. M.	Feb. 1, 1893 Sept. 2, 1896
Snow, Frank Herbert. Chf. Engr., State Dept. of Health, Harrisburg, Pa	Assoc. M. M.	June 4, 1895 May 3, 1904
Snow, Franklin Augustus. Contr. for Public Works, The Master Bldrs. Assoc., 166 Devonshire St., Boston, Mass.		Jan. 4, 1905
Snow, Jesse Baker. Asst. Engr., P. T. & T. R. R. Co., 345 East 33d St., New York City (Res., 330 South Lefferts Ave., Richmond Hill, N. Y.)		Oct. 2, 1907
Snow, Jonathan Parker. Chf. Engr., B. & M. R. R., Boston, Mass		June 3, 1885
Snow, William Pliny. Const. Engr., Lockwood, Greene & Co., 93 Federal St., Boston, Mass		Feb. 5, 1902
Snyder, Baird, Jr. Gen. Supt., Lehigh Coal & Nav. Co., Lansford, Pa		Mar. 2, 1904
Snyder, Christopher Henry. Contr. Mgr., San Francisco Office of Milliken Bros., New York, 607 Humboldt Bank Bldg., San Francisco, Cal		Oct. 2, 1901
Snyder, George Duncan. Prin. Asst. Engr., Hudson & Manhattan R. R., 30 Church St., New York City	Assoc. M. M.	Nov. 6, 1895 Sept. 4, 1901
Somerville, Robert. Asst. Chf. Engr., Board of Miss. Levee Commrs., Greenville, Miss		June 1, 1887
Sonderegger, Arthur Ludwig. 635 Central Bldg., Los Angeles, Cal		Oct. 5, 1909
Sonne, Otto. 132 Nassau St., New York City		Sept. 7, 1887
Sooysmith, Charles. Cons. Engr., 71 Broadway, New York City		May 5, 1886
Soper, George Albert. Cons. San. Engr., 29 Broadway, New York City	Assoc. M. M.	Feb. 6, 1901 April 4, 1905
Sorzano, Julio Federico. Cons. Engr., 52 Broadway, New York City (Res., 228 Garfield Pl., Brooklyn, N. Y.)		Sept. 3, 1884
Souder, Harrison. Gen. Supt., Cornwall Ore Bank Co., Cornwall, Lebanon Co., Pa		Jan. 6, 1904
Soulé, Frank. Prof. Emeritus of Civ. Eng., Univ. of California, 2511 Hillegass Ave., Berkeley, Cal		Mar. 1, 1905
Soule, Howard. Syracuse, N. Y		Mar. 17, 1869
Souther, Henry. Cons. Engr., Hartford, Conn		Dec. 4, 1907
Spalding, Frederick Putnam. Prof. of Civ. Eng., Univ. of Missouri, 901 Virginia Ave., Columbia, Mo		Dec. 2, 1891
Spaulding, Charles Lincoln. Res. Engr., Hudson Dist., Electric Zone, N. Y. C. & H. R. R. R., 85 Main St., Yonkers, N. Y.		April 1, 1908
Speakman, Richard Edward. City Engr., Brandon, Man., Canada		Jan. 4, 1910

		Date of Membership.
Spear, Walter Evans. Dept. Engr., Board of Water Supply of the City of New York, 299 Broadway, New York City	Assoc. M. M.	Feb. 3, 1904 Mar. 2, 1909
Spencer, John Clark. Cons. and Contr. Engr., 1024 Rockefeller Bldg., Cleveland, Ohio	Assoc. M. M.	May 6, 1896 Dec. 6, 1904
Sperry, Henry Muhlenberg. Sales Mgr., Gen. Ry. Signal Co., Rochester, N. Y		Nov. 6, 1901
Spicer, Vibé Kierulff. Canadian Mgr., The Union Switch & Signal Co., Commercial Union Bldg., Montreal, Que., Canada		June 5, 1895
Spilsbury, Edmund Gybbon. Cons. Engr., 45 Broadway, New York City		Dec. 7, 1892
Spofford, Charles Milton. Hayward Prof. of Civ. Eng., Mass. Inst. Tech., Boston, Mass	Assoc. M. M.	June 4, 1902 June 6, 1905
Spooner, Allen Newhall. 157 West 87th St., New York City		Dec. 5, 1900
Spooner, Herman Winslow. Civ. Engr., Water Dept., 6 Proctor St., Gloucester, Mass		Jan. 3, 1906
Sprague, Ernest Marshall. Contr. Engr., Am. Bridge Co. of N. Y., 1310 Rockefeller Bldg., Cleveland, Ohio		Oct. 3, 1906
Sprague, Frank Julian. Cons. Engr., 165 Broadway, New York City		June 1, 1904
Spring, Francis Joseph Edward. Engr.-Chairman, Port Trust, Madras, India		Jan. 3, 1894
Sproul, Archibald Alexander. Div. Engr., Board of Water Supply, City of New York, Peekskill, N. Y		May 1, 1907
Staats, John Henry. Vice-Pres. and Treas., R. P. & J. H. Staats, Engrs. and Contrs., 29 Broadway, New York City		Mar. 5, 1884
Staats, Robert Parker. (R. P. & J. H. Staats, Civ. Engrs. and Contrs.), 29 Broadway, New York City	Jun. M.	Nov. 3, 1875 July 1, 1885
Stacpoole, Stephen Westropp. Cons. Engr., 3a Avenida de la Libertad No. 5, Orizaba, Vera Cruz, Mexico	Assoc. M. M.	May 6, 1896 Sept. 4, 1901
Staley, Cady. Care, Case School of Applied Science, Cleveland, Ohio		Mar. 17, 1869
Stanford, Homer Reed. Civ. Engr., U. S. N., Navy Yard, Philadelphia, Pa	Jun. Assoc. M. M.	Oct. 1, 1890 Nov. 7, 1894 Sept. 4, 1901
Staniford, Charles Wilkinson. Chf. Engr., Dept. of Docks and Ferries, Pier A, North River, New York City		May 7, 1890
Stanton, Frank McMillan. Min. Engr., Lincoln Trust Bldg., 208 Fifth Ave., New York City		Feb. 1, 1899
Stanton, Robert Brewster. Civ. and Min. Engr., 32 Nassau St., Room 557, New York City		Sept. 1, 1880

			Date of Membership.
	Starrett, Milton Gerry. Cons. Engr., 621 Broadway (Res., 223 East 17th St.), New York City		Jan. 3, 1900
	Stauffer, David McNeely. 264 Palisade Ave., Yonkers, N. Y.		Sept. 2, 1874
	Stayton, Edward Moses. 423 East Kansas St., Independence, Mo	Assoc. M. M.	Feb. 4, 1903 Nov. 5, 1907
N.	STEARNS, FREDERIC PIKE. (*Past-President*). Cons. Engr., 1 Ashburton Pl., Boston, Mass		Oct. 2, 1878
	Steece, Emmet Abner. Fayetteville, Ark	Assoc. M. M.	Dec. 4, 1901 Mar. 1, 1904
	Stephens, Clinton F. Sulphur Springs Landing, Mo		Sept. 5, 1877
	Stern, Eugene Washington. Cons. Engr., 103 Park Ave., New York City		Mar. 3, 1897
	Stern, Isaac Farber. Engr. of Bridges, C. & N. W. R. R., 4943 Calumet Ave., Chicago, Ill		April 1, 1908
	Stevens, Frank Stoddard. Supt., P. & R. Ry., Reading, Pa.		Oct. 3, 1883
	Stevens, Horace Edward. Director, Winston Bros. Co., Contrs., Minneapolis (Res., 530 Grand Ave., St. Paul), Minn	Jun. M.	Nov. 1, 1876 April 4, 1888
	Stevens, Howard Eveleth. Bridge Engr., N. P. Ry. Co., St. Paul, Minn		April 6, 1909
	Stevens, John Frank. Pres., Oregon Trunk Ry., Portland, Ore		June 6, 1888
	Stewart, John Muirhead. Asst. Engr., Dept. of Docks and Ferries, East 24th St. Office, New York City	Jun. M.	Mar. 2, 1887 Jan. 4, 1888
	Stewart, Robert Dee. Cons. Engr., Box 408, Laramie, Wyo		Nov. 1, 1905
	Stickney, George Fetter. Superv. Engr., New York State Barge Canal, Barge Canal Office, Albany, N. Y	Jun. Assoc. M. M.	May 1, 1894 April 5, 1899 Sept. 4, 1906
	Stillwell, Lewis Buckley. 100 Broadway, New York City		Oct. 2, 1901
	Stoddard, George Caleb. Civ. and San. Engr., 215 West 125th St., New York City		April 4 1900
N.	Stone, Edward Herbert. Freshford, Somerset, England		Dec. 5, 1888
	Stone, Everett Edward. 1891 Beacon St., Brookline, Mass		May 4, 1904
	Stone, Henry Morton. Dist. Engr., C., R. I. & P. Ry., Topeka, Kans		April 3, 1907
	Storey, William Benson, Jr. Vice-Pres., A., T. & S. F. Ry. Co., 1033 Railway Exchange, Chicago, Ill		Jan. 2, 1889
	Storrow, Samuel. Civ. and Min. Engr., 906 Wright & Callender Bldg., Los Angeles, Cal	Jun. Assoc. M. M.	Sept. 10, 1891 Oct. 2, 1895 Mar. 1, 1904
	Stott, Henry Gordon. Supt. of Motive Power, Interborough Rapid Transit Co., Rochelle Heights, New Rochelle, N. Y.		July 1, 1908
	Stowe, Harold Clair. (Clarke & Stowe, Engrs. and Contrs.), 221 Greenpoint Ave., Brooklyn, N. Y	Assoc. M. M.	April 7, 1897 Jan. 4, 1910

		Date of Membership.
Stowell, Charles Frederick. (Stowell & Cunningham), 51 State St., Albany, N. Y.		April 4, 1888
Strachan, Joseph. 352 Putnam Ave., Brooklyn, N. Y.	Assoc. M. M.	May 4, 1892 May 4, 1898
Strachan, Robert Charles. Richmond Hill, N. Y.		Aug. 31, 1909
Street, Leonard Lee. Civ. Engr. and Contr., 27 Salcombe St., Dorchester, Mass		Oct. 5, 1909
Strehlow, Oscar Emil. Contr. Engr., James O. Heyworth, Harvester Bldg., Chicago, Ill.	Assoc. M. M.	Mar. 6, 1901 Sept. 6, 1904
Strickler, Gratz Brown. Res. Engr., Almendares River Bridge, Apartado 705, Havana, Cuba.	Jun. Assoc. M. M.	Jan. 5, 1897 Jan. 4, 1899 Nov. 1, 1904
Strobel, Charles Louis. Pres., Strobel Steel Constr. Co., 1744 Monadnock Blk., Chicago, Ill		Dec. 3, 1879
Strong, Carlton. Bellefield Dwellings, Pittsburg, Pa		Jan. 4, 1910
Strong, Mason Romeyn. Cons. Engr. and Archt., 7 Wall St., New York City		Mar. 6, 1901
Strouse, William Franklin. Asst. Engr., B. & O. R. R., B. & O. Bldg. (Res., 400 Forest Rd., Roland Park), Baltimore, Md		Mar. 1, 1905
Stuart, Alfred Allen. Cons. Engr., Degnon Contr. Co.; Secy., Degnon Realty & Terml. Impvt. Co., 60 Wall St., New York City		Oct. 7, 1891
STUART, FRANCIS LEE. (*Director*). Chf. Engr., Erie R. R. Co., 50 Church St., New York City		May 3, 1899
Stuart, Joseph Thompson. 311 Arcade Bldg., Philadelphia, Pa		May 4, 1904
Stubbs, Linton Waddell. Superv. Engr., Galveston Causeway, Galveston, Tex		Oct. 3, 1888
Sturtevant, Carleton William. Engr. with Stewart Kerbaugh Shanley Co., Brewerton, N. Y		Oct. 2, 1901
Sublette, George Washington. Cons. Engr., Const. Engr. and Contr., 3315 Irving Ave. S., Minneapolis, Minn		Oct. 1, 1902
Suhr, Otto Bruno. Engr., The Ontario Power Co., Niagara Falls, N. Y		June 1, 1904
Sullivan, John G. Asst. Chf. Engr., C. P. Ry., Montreal, Que., Canada		Sept. 6, 1899
SUMNER, HORACE AUGUSTUS. (*Director*). Chf. Engr., Denver, N. W. & Pac. Ry., Room 717, Majestic Bldg., Denver, Colo		Oct. 4, 1899
Sumner, Robert Swan. Cons. Civ. Engr., Suite 438, Century Bldg., Denver, Colo	Assoc. M. M.	June 3, 1903 Nov. 5, 1907
Sundstrom, Carl Alfred. Surv. and Regulator, 8th Dist., Philadelphia, 4444 Main St., Manayunk, Philadelphia, Pa.		Oct. 3, 1894
Supplee, Jesse. Scott Blk., 10th and State Sts. (Res., 239 West 5th St.), Erie, Pa		June 3, 1903

		Date of Membership.
Suter, Charles Russell. Brig.-Gen., U. S. A. (*Retired*), 287 Walnut St., Brookline, Mass		April 1, 1896
Sutermeister, Arnold Henry. Engr., Public Service Comm., 2d Dist., Albany, N. Y		June 3, 1902
Sutton, Frank. Geographer, U. S. Geological Survey, Washington, D. C		Oct. 3, 1906
Swaab, Solomon Mark. Chf. Engr., Millard Constr. Co., East Market St. Subway, 433 Market St., Philadelphia, Pa	Jun. Assoc. M. M.	May 3, 1898 Nov. 1, 1899 May 5, 1908
Swain, George Fillmore. Prof. of Civ. Eng., Harvard Univ.; Cons. Engr., Mass. R. R. Comm.; Member, Boston Transit Comm., Pierce Hall, Oxford St., Cambridge, Mass	Assoc. M.	Sept. 5, 1883 Mar. 2, 1892
Swanker, John Edward. Gen. Mgr., Tees Side Bridge & Eng. Works, Ltd., Middlesbrough, England		May 4, 1904
Swendsen, George Lewis. Hydr. Engr., 27 Shaw Blk., Boise, Idaho		June 7, 1905
SWENSSON, EMIL. (*Vice-President*). Cons. and Constr. Engr., 925 Frick Bldg., Pittsburg, Pa		June 7, 1893
Swezey, Edwin Charles. Gen. Supt., Brooklyn Grade Crossing Comm., 44 Court St., Brooklyn, N. Y		Mar. 7, 1906
Swinburne, George Way. 61 Whittlesey Ave., East Orange, N. J		May 7, 1902
Sylvester, Frank McClellan. Box 1871, Spokane, Wash		Feb. 1, 1905
Sylvester, Ira Wallace. City Engr., Rapides Bank Bldg., Alexandria, La		Nov. 7, 1906
Taber, George Aymar. Engr. in Chg., Designing Div., Dept. of Water Supply, Gas and Electricity, 43 Municipal Bldg., Brooklyn, N. Y	Jun. Assoc. M. M.	April 30, 1895 June 7, 1899 Dec. 4, 1906
Tabor, Ernest Frederick. Project Engr., U. S. Reclamation Service, St. Ignatius, Mont		May 1, 1907
Tainter, Frank Stone. 90 West St., New York City	Assoc. M. M.	Jan. 3, 1900 Mar. 31, 1908
TALBOT, ARTHUR NEWELL. (*Director*). Prof. of Municipal and San. Eng., and in Chg. of Theoretical and Applied Mechanics, Univ. of Illinois, Urbana, Ill		April 4, 1888
Talbott, Harry Elstner. Dayton, Ohio		June 6, 1900
Talcott, Harry Randolph. Engr. of Surveys, B. & O. R. R., Central Office Bldg., Baltimore, Md		Oct. 5, 1904
Tanabe, Sakuro. Prof. of Civ. Eng., Kyoto Imperial Univ., Kyoto, Japan		Oct. 4, 1905
Tatum, Sledge. Drainage Investigations, U. S. Geological Survey, Washington, D. C		Jan. 4, 1910

		Date of Membership.
Taussig, Hubert Primm. Cons. Civ. Engr., 14th and Locust Sts., St. Louis, Mo		Oct. 3, 1894
Taylor, Benjamin Henry. Special Agt., Carnegie Steel Co. (Res., 323 Swissvale Ave., Edgewood Park), Pittsburg, Pa		May 4, 1904
Taylor, Charles Frederick. Pres., Maritime Dredging Co., 78 Broad St., New York City.	Assoc. M. M.	Sept. 4, 1895 April 4, 1905
Taylor, Edward Ballinger. Third Vice-Pres., Penn. Co. and P., C., C. & St. L. Ry. Co., Room 901, Union Station, Pittsburg, Pa		Sept. 3, 1884
Taylor, Edwin Alexander. Supt. of Constr., Water Board, 360 East 57th St., Portland, Ore	Assoc. M. M.	June 7, 1905 June 2, 1908
Taylor, George McClellan. 2 Peters Pl., Red Bank, N. J		Dec. 1, 1908
Taylor, Gorham Andrew. U. S. Engr.'s Office, Duluth, Minn		Feb. 1, 1910
Taylor, Harry. Lt.-Col., Corps of Engrs., U. S. A., New London, Conn		Oct. 7, 1896
Taylor, Howard Flanders. Locating Engr., Cent. of Ga. Ry., 800 Brighton Ave., Kansas City, Mo	Jun. Assoc. M. M.	Feb. 28, 1899 June 6, 1906 April 6, 1909
Taylor, Hugh McGehee. Asst. Gen. Mgr., National Railways of Mexico, City of Mexico, Mexico		July 1, 1909
Taylor, James Townsend. Cons. Hydr. Engr., Honolulu, Hawaii		Jan. 3, 1894
Taylor, Lucian Arnold. Cons. Engr., 619 Tremont Bldg., Boston, Mass		Nov. 4, 1891
Taylor, Samuel Alfred. Cons., Civ. and Min. Engr., 900 Lewis Blk., Pittsburg, Pa		Oct. 7, 1903
Taylor, Thomas Ulvan. Prof. of Civ. Eng., Univ. of Texas, Austin, Tex	Assoc. Assoc. M. M.	Jan. 31, 1893 Oct. 2, 1895 Oct. 2, 1901
Taylor, William Dana. Chf. Engr., T., St. L. & W. R. R., C. & A. R. R., Minn. & St. L. R. R. and Iowa Cent. Ry., 900 Ry. Exchange, Chicago, Ill		Mar. 1, 1899
Taylor, William Gavin. Passaic Val. Sewerage Commrs., 92 Park Pl., Newark, N. J		June 5, 1907
Tays, Eugene Augustus Hoffman. Min. Engr., San Blas, Distrito de Fuerte, Sinaloa, Mexico (*via* Nogales, Ariz.)		April 6, 1898
Teichman, Frank. Designing Engr., U. S. Reclamation Service, Phœnix, Ariz		Oct. 5, 1904
Teilman, Ingvart. Mgr. and Chf. Engr., Fresno & Consolidated Canal Cos., Fresno, Cal		June 3, 1903
Temple, Edward Brinton. Asst. Chf. Engr., P. R. R., Broad St. Station, Philadelphia, Pa		Oct. 2, 1907

		Date of Membership.
Temple, John Charles. Hydr. Engr., 2224 Land Title Bldg., Philadelphia, Pa.		May 4, 1898
Temple, William Henry Giles. Civ. and Hydr. Engr., 75 Westminster St., Providence, R. I.		Feb. 3, 1892
Tenney, Willis Robinson. Room 21, Municipal Bldg., Brooklyn, N. Y.		May 4, 1909
Terrell, Williford Harry. Cons. Civ. and Hydr. Engr., Clyde, N. C.	Assoc. M. M.	Nov. 1, 1905 Dec. 3, 1907
Terry, John Hermon. Secy. and Treas., Latta & Terry Constr. Co., 1319 Penna. Bldg., Philadelphia, Pa.		Oct. 2, 1907
Thacher, Edwin. Cons. Engr. and Member, Concrete-Steel Eng. Co., Park Row Bldg., New York City		Feb. 17, 1869
Thackray, George Edward. Structural Engr., Cambria Steel Co., Johnstown, Pa.	Jun. M.	Sept. 6, 1882 April 7, 1886
Thayer, Russell. United Gas Impvt. Co., Philadelphia, Pa.		Dec. 6, 1882
Thian, Prosper Eugene. Asst. Engr., N. P. Ry. Co., Mandan, N. Dak.		Nov. 7, 1906
N. Thomas, Benjamin Franklin. U. S. Prin. Asst. Engr., 415 Custom House, Cincinnati, Ohio		April 6, 1887
Thomas, Chester Ashley. Res. Mgr., Yukon Gold Co., Dawson, Y. T., Canada		Nov. 8, 1909
Thomas, David Gorton. Chf. Engr., The Denver Union Water Co., Denver, Colo.		June 1, 1909
Thompson, Benjamin. Cons. and Contr. Engr., 311 Am. Nat. Bank, Tampa, Fla.		July 3, 1889
Thompson, Ellis Dunn. Chf. Engr., The Breakwater Co., 1222 Arcade Bldg., Philadelphia, Pa.		Feb. 1, 1899
Thompson, Fred. Civ. Engr., U. S. N., Yards and Docks, Navy Dept., Washington, D. C.		Oct. 1, 1902
Thompson, Gaylord. Chf. Engr., Ohio Elec. Ry. Co., Springfield, Ohio		April 2, 1890
Thompson, Henry Clark. Div. Engr., N. Y. C. & H. R. R. R., West 42d St. Ferry, New York City		Feb 4, 1903
THOMPSON, SAMUEL CLARENCE. (*Director*). Engr. of Highways, Borough of the Bronx, 177th St. and 3d Ave., New York City		Feb. 6, 1889
Thompson, Sanford Eleazer. Cons. Engr., Newton Highlands, Mass.	Assoc. M. M.	April 1, 1896 May 1, 1906
Thompson, Wilford Ashford. First Asst. City Engr.; Vice-Pres., East St. Louis Eng. Co., Arcade Bldg. (Res., 1802 College Ave.), East St. Louis, Ill.	Jun. Assoc. M. M.	Oct. 1, 1901 Oct. 4, 1905 Nov. 30, 1909
Thompson, William Andrew. U. S. Asst. Engr., Upper Mississippi River Impvt., La Crosse, Wis.		Oct. 7, 1896

		Date of Membership.
THOMSON, ERNEST BURSLEM. U. S. Asst. Engr., Care, Walter Mucklow, 1250 Riverside Ave., Jacksonville, Fla.	Assoc. M. M.	June 5, 1901 May 31, 1904
THOMSON, JOHN. 253 Broadway, New York City		Mar. 2, 1887
THOMSON, REGINALD HEBER. City Engr. (Res., 955 Thirteenth Ave., N.), Seattle, Wash.		Dec. 2, 1903
THOMSON, THOMAS KENNARD. Cons. Engr., 50 Church St., New York City	Jun. Assoc. M. M.	Oct. 3, 1888 June 3, 1891 Dec. 4, 1895
THORNLEY, JULIAN. Div. Engr., State Water Supply Comm., Albany, N. Y.	Assoc. M. M.	Jan. 2, 1901 Sept. 5, 1905
TIBBALS, GEORGE ATTWATER. Secy. and Treas., The Continental Iron Works, Brooklyn, N. Y.	Jun. M.	May 2, 1888 Mar. 4, 1896
TIBBALS, SAMUEL GAYLORD. The Continental Iron Works, Brooklyn, N. Y.	Jun. M.	May 2, 1888 May 5, 1897
TIGHE, JAMES LAWRENCE. City Engr. and Engr., Holyoke Water Works, Holyoke, Mass.	Assoc. M. M.	Oct. 5, 1898 May 31, 1904
TILLSON, GEORGE WILLIAM. Chf. Engr., Bureau of Highways, Borough of Manhattan, 13 Park Row, New York City		Oct. 7, 1896
TIMONOFF, VSEVOLOD EVGUENIEVITCH. Director, Statistical Dept., Ministry of Ways of Communications; Prof., Inst. of Ways of Communications; Member of the Technical Counsels, Ministry of Ways of Communications, Ministry of Commerce and Industry, Ministry of Agriculture, Perspective Zabalkanski 9, St. Petersburg, Russia		May 3, 1893
TINGLEY, RICHARD HOADLEY. 50 Church St., New York City		April 3, 1901
TINKER, GEORGE HENRY. Bridge Engr., N. Y. C. & St. L. R. R., 220 Hickox Bldg., Cleveland, Ohio		Aug. 31, 1909
TINKHAM, SAMUEL EVERETT. Asst. Engr., Eng. Dept., City Hall, Boston, Mass.		Mar. 2, 1892
TINTORER Y GIBERGA, JOSEPH. Claris 32, Barcelona, Spain		May 5, 1880
TITTMANN, OTTO HILGARD. U. S. Coast and Geodetic Survey, Washington, D. C.		June 4, 1902
TODD, ALEXANDER MILLER. U. S. Asst. Engr., P. O. Box 404, Vicksburg, Miss.	Jun. Assoc. M. M.	Oct. 1, 1895 Oct. 2, 1901 June 6, 1905
TODD, FRANK HERBERT. City Engr., Box 868, El Paso, Tex.		Feb. 6, 1889
TOLLINGER, EDWARD CHANDLER. U. S. Asst. Engr., P. O. Box 404, Vicksburg, Miss.		June 4, 1902
TOMLINSON, ALFRED THOMAS. Dist. Engr., Grand Trunk Pacific Ry., Districts C and D, Matheson, Ont., Canada		Sept. 7, 1887
TOMLINSON, SAM. 1 Raffles Quay, Singapore, Straits Settlements		April 6, 1892
TOMPKINS, EDWARD DE VOE. Chf. Engr., Tompkins Eng.-Constr. Co., 81 East 125th St., New York City	Jun. Assoc. M. M.	Feb. 2, 1897 Dec. 3, 1902 May 1, 1906

		Date of Membership.
Tompson, George Morris. Civ. and Cons. Engr., Parker Rd., Wakefield, Mass.		May 2, 1888
Tone, Sumner La Rue. Second Vice-Pres., Pittsburg Rys. Co., Allegheny County Light Co., 435 Sixth Ave., Pittsburg, Pa.		Dec. 4, 1901
Tonkin Thomas, Juan. Care, Bank of Chili, Santiago, Chili	Assoc. M. M.	Mar. 7, 1900 Jan. 7, 1908
Tönnesen, Tobias. Gen. Representative and Engr.-in-Chf., South West Africa Co., Ltd., Grootfontein, German S. W. Africa		May 1, 1901
Torrance, William Martin. Cons. Civ. Engr., 63 Sanford St., East Orange, N. J.		July 1, 1909
Touceda, Enrique Augusto. Chemist and Metallurgist; Prof., Metallurgy, Rens. Poly. Inst.; Address, Broadway, Cor. Thacher St., Albany, N. Y.		Jan. 3, 1900
Tower, Morton Loudon. U. S. Engr. Office, 665 Monadnock Bldg., San Francisco, Cal.	Assoc. M. M.	May 6, 1908 July 1, 1909
Towl, Forrest Milton. Cons. Engr., 26 Broadway, New York City (Res., 794 Carroll St., Brooklyn, N. Y.)		Feb. 5, 1896
Towle, Stevenson. Civ. and Cons. Engr., 7 East 42d St., New York City		Feb. 19, 1868
Townsend, Curtis McDonald. Col., Corps of Engrs., U. S. A., Jones Bldg., Detroit, Mich.		Nov. 1, 1893
Trask, Frank Ellsworth. Cons. Civ. and Hydr. Engr., 421 Homer Laughlin Bldg., Los Angeles, Cal.	Assoc. M. M.	June 5, 1895 Jan. 2, 1901
Treadwell, Lee. Vice-Pres. and Chf. Engr., Union Bridge & Constr. Co., 903 Sharp Bldg., Kansas City, Mo.	Jun. Assoc. M. M.	Nov. 5, 1890 Oct. 4, 1893 Dec. 2, 1896
Tretter, Gustav Adolph. Erection Mgr., Virginia Bridge & Iron Co., Roanoke, Va.		April 6, 1904
Tribus, Louis Lincoln. Cons. Engr. and Acting Commr. of Public Works, Borough of Richmond, New York City; Civ. and Hydr. Engr. (Tribus & Massa), 86 Warren St., New York City	Jun. Assoc. M. M.	April 4, 1888 June 1, 1892 April 1, 1896
Triest, Wolfgang Gustav. Vice-Pres., The Snare & Triest Co., 143 Liberty St., New York City	Jun. Assoc. M.	Sept. 3, 1890 Mar. 6, 1900 Jan. 31, 1905
Tripp, Oscar Holmes. Room 30, Court House, Rockland, Me.	Assoc. M. M.	Oct. 7, 1896 Sept. 5, 1905
Trocon, Albert Alexander. (The Midland Bridge Co., Freygang & Trocon, Proprs.), Kansas City, Mo.		May 1, 1895
Trotter, Alfred Williams. 141 Broadway, New York City	Jun. M.	Sept. 5, 1883 Nov. 7, 1894

		Date of Membership.
Trout, Charles Eliphalet. Asst. Engr., Dept. of Docks and Ferries, Pier A, North River, New York City	Jun. Assoc. M. M.	Oct. 31, 1899 Jan. 8, 1902 Oct. 30, 1906
Trundle, Horatio Hartley. Civ. Engr. and Contr., Leesburg, Loudoun Co., Va	Assoc. M. M.	June 7, 1899 Mar. 6, 1901
Tsuji, Taro. Engr., Imperial Govt. Rys., Hongo Yumicho Nichome 24, Tokyo, Japan	Jun. Assoc. M. M.	Oct. 8, 1891 Oct. 4, 1899 Mar. 1, 1904
Tucker, Edward Austin. Structural Engr., 683 Atlantic Ave., Boston, Mass		June 6, 1906
Tucker, Lester Waldo. With Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City		Dec. 4, 1901
Tucker, Ross Francis. Pres., Concrete Products Co., 35 West 32d St., Room 1103, New York City		Oct. 7, 1903
Tucker, William Conquest. 156 Fifth Ave., New York City	Jun. Assoc. M. M.	May 5, 1891 Dec. 5, 1894 Jan. 3, 1905
Tuckey, Thomas William Townsend. Engr.-in-Chf., Tientsin-Pukow Ry., Nanking, China		June 3, 1903
Turner, Claude Allen Porter. Cons. Engr., 816 Phœnix Bldg., Minneapolis, Minn		Mar. 6, 1901
Turner, Daniel Lawrence. Gen. Insp. of Stations, Board of Rapid Transit R. R. Commrs. of the City of New York, 220 West 107th St., New York City	Assoc. M. M.	Feb. 2, 1898 Jan. 3, 1905
Turner, Edmund Kimball. 53 State St., Boston, Mass		Nov. 4, 1891
Turner, Nathaniel. 228 Calle de Hidalgo, Monterey, Mexico		Mar. 6, 1895
Turner, Orville Hickman Browning. Chf. Engr., St. Louis, Rocky Mt. & Pac. Ry. Co., Raton, N. Mex		Feb. 2, 1909
Tuska, Gustave Robitscher. Cons. Engr., 68 William St., New York City	Jun. Assoc. M. M.	Mar. 6, 1894 Jan. 1, 1896 Nov. 2, 1900
Tutein-Nolthenius, Rudolph Peter Johann. Heerengracht No. 132, Amsterdam, The Netherlands		Dec. 6, 1899
Tuthill, Job. Engr., M. of W., Cin., Hamilton & Dayton Ry., Cincinnati, Ohio	Jun. M.	June 6, 1888 Oct. 4, 1893
Tuttle, Arthur Smith. Engr. in Chg., Div. of Public Impvts., Board of Estimate and Apportionment, 277 Broadway, New York City	Jun. Assoc. M. M.	Mar. 2, 1887 May 2, 1894 Mar. 2, 1898
Tutwiler, Thomas Henry. Pres. and Gen. Mgr., The Memphis St. Ry. Co., Memphis, Tenn		June 4, 1902
Tye, William Francis. 68 Rosemount Ave., Montreal, Que., Canada		Sept. 1, 1897
Tyler, William Dowlin. Chf. Engr., Clinchfield Coal Corp., Dante, Va		Nov. 30, 1909
Tyson, Anderson Harvey. Glen Ridge, N. J		Oct. 2, 1889

		Date of Membership.
Ubsdell, John Arnold, Jr. Supt. and Naval Archt., Great Lakes Eng. Works, 230 Hubbard Ave. (Res., 294 West Grand Boulevard), Detroit, Mich		June 3, 1908
Uhlig, Carl. Asst. Engr., Board of State Harbor Commrs., Ferry Bldg., San Francisco, Cal		Oct. 7, 1903
Ulrich, John Clarence. P. O. Box 1342, Denver, Colo		Mar. 4, 1908
Upham, Charles Clifton. Vice-Pres. and Gen. Mgr., New York Steam Co., 140 Cedar St., New York City		April 7, 1897
Vail, Charles Davis. (Vail, Walbron & Read), 247 Equitable Bldg., Denver, Colo	Assoc. M. M.	June 6, 1900 Aug. 31, 1909
Value, Beverly Reid. Empire Eng. Corp., 60 Wall St., New York City		Jan. 2, 1901
Van Alstyne, Henry Arthur. 149 Echo Ave., New Rochelle, N. Y	Assoc. M. M.	June 6, 1900 Dec. 3, 1907
Van Buren, John D. New Brighton, Borough of Richmond, N. Y		May 20, 1868
Van Buren, Robert. 58 West Ave., Norwalk, Conn		June 17, 1868
Van Cleve, Aaron Howell. Cons. Engr., Niagara Falls, N. Y	Jun. Assoc. M. M.	May 31, 1892 Dec. 5, 1894 Nov. 1, 1904
Vandevanter, Charles Oscar. Leesburg, Va		Sept. 2, 1896
Van Frank, Phillip Riley, Jr. Care, U. S. Engr. Office, Little Rock, Ark		Aug. 31, 1909
Van Hoesen, Edmund French. Expert on Railroad Crossings, Barge Canal, Albany, N. Y		July 1, 1891
Van Horne, John Garret. 165 Broadway, Room 2611, New York City		Feb. 4, 1880
Van Keuren, Charles Augustus. Chf. Engr., Board of Street and Water Commrs., Jersey City, N. J		May 3, 1905
Van Norden, Ernest Maitland. Civ. Engr., New York Edison Co., 55 Duane St., New York City (Res., 1419 Pacific St., Brooklyn, N. Y.)	Assoc. M. M.	May 6, 1903 Oct. 2, 1906
Van Norden, Rudolph Warner. Cons. Engr., 407 Union Trust Bldg., San Francisco, Cal		July 1, 1909
Van Orden, Charles Hopkins. Catskill, N. Y		June 1, 1898
Van Ornum, John Lane. Prof. of Civ. Eng., Washington Univ., St. Louis, Mo	Assoc. M. M.	Oct. 3, 1894 Oct. 4, 1899
Van Sant, Robert Lawrence. Contr. Engr., 421 Olive St., St. Louis, Mo		Sept. 3, 1884
Van Vleck, John. 100 Broadway, New York City		May 3, 1905
Van Winkle, Edgar Beach. 115 East 70th St., New York City.		Dec. 2, 1868
Van Winkle, Edward. Cons. Patent Engr., The West St. Bldg., New York City		Nov. 30, 1909

		Date of Membership.
Vaughan, Charles Herbert. 3409 Fifth Ave., Beaver Falls, Pa.		May 2, 1906
Vaughan, George Washington. Engr., M. of W., N. Y. C. & H. R. R. R. Co., Grand Central Palace, New York City	Jun. M.	Mar. 3, 1886 Nov. 4, 1896
Vaughn, George Washington. Engr. in Chg., Santa Fe Track Elevation, Joliet, Ill.		June 3, 1891
Venable, William Mayo. Mgr., Blackstaff Eng. Co. (Res., 216 Woodbine St.), Louisville, Ky.	Assoc. M. M.	Sept. 4, 1901 Oct. 1, 1907
Verrill, George Elliot. U. S. Asst. Engr., 407 First National Bank Bldg., New Haven, Conn.		Mar. 2, 1904
Veuve, Erle Leroy. Cons. Engr., 693 Pacific Electric Bldg., Los Angeles, Cal.	Jun. M.	Sept. 3, 1901 Feb. 2, 1909
Vielé, Maurice Augustus. 49 Wall St., New York City	Jun. Assoc. M. M.	Feb. 4, 1891 Sept. 7, 1892 Oct. 6, 1897
Vincent, Edward Franklin. Asst. Chf. Engr., Colo. & South. Ry. Co., 805 Cooper Blk., Denver, Colo.		Aug. 31, 1909
Vincent, Edwin Derickson. Res. Engr., U. S. Reclamation Service, Phœnix, Ariz.		May 4, 1909
Vogleson, John Albert. 1317 Spruce St., Philadelphia, Pa.	Assoc. M. M.	Jan. 2, 1901 Mar. 31, 1908
von Emperger, Fritz Edler. K. K. Oberbaurat; Rat im K. K. Patentamt; Herausgeber von *Beton und Eisen*, Vienna IV, Austria		Feb. 5, 1908
von Geldern, Otto. Cons. Engr., 865 Pacific Bldg., San Francisco, Cal.		May 4, 1892
von Leer, Isaac Wayne. Civ. and Min. Engr., 1520 Chestnut St., Philadelphia, Pa.		May 3, 1899
von Schon, Hans August Evald Conrad. Cons. Engr., 603 Wayne County Bank Bldg., Detroit, Mich.		Sept. 2, 1902
Voorhees, Theodore. Vice-Pres., P. & R. Ry. Co., Reading Terminal, Philadelphia, Pa.		May 6, 1885
Vorce, Clarence Browning. Care, Sanderson & Porter, 52 William St., New York City	Jun. Assoc. M. M.	April 30, 1895 Oct. 7, 1896 May 2, 1900
Vose, Richard Hampton. Colima, Estado de Colima, Mexico		Oct. 7, 1908

Waddell, John Alexander Low. (Waddell & Harrington, Cons. Engrs.), Orear-Leslie Bldg., Kansas City, Mo.		Oct. 5, 1881
Waddell, Montgomery. Cons. Engr., 1 West 101st St., New York City	Jun. M.	Sept. 1, 1886 Sept. 2, 1896
Waddell, Robert William. 3212 Central St., Kansas City, Mo.		Sept. 4, 1901
Wadsworth, George Reed. Cons. Engr., 19 Congress St., Boston, Mass.	Assoc. M. M.	Nov. 7, 1906 Nov. 8, 1909

		Date of Membership.
Wadsworth, Henry Hayes. U. S. Asst. Engr., 1005 Hooker & Lent Bldg., San Francisco, Cal		Oct. 2, 1901
Wadsworth, Joel Edward. Res. Engr., Am. Bridge Co., 30 Church St., New York City	Jun. Assoc. M. M.	Dec. 5, 1893 May 5, 1897 June 6, 1905
Wagner, Bernard Matthew. Engr. in Chg., Watershed Div., Dept. of Water Supply, Gas and Electricity, Rockville Center, N. Y.	Assoc. M. M.	May 3, 1899 Dec. 1, 1903
Wagner, Joseph Christian. Surv. and Regulator, 9th Survey Dist., Dept. of Public Works, Philadelphia; Office, Chelton Ave. and Greene St., Germantown (Res., 1539 North 12th St.), Philadelphia, Pa	Assoc. M. M.	June 7, 1899 June 5, 1906
Wagner, Samuel Tobias. Asst. Engr., P. & R. Ry., Huntingdon St. Station, Philadelphia, Pa		Feb. 2, 1887
Wagoner, Luther. Cons. Engr., 910 Pacific Bldg., San Francisco, Cal		May 2, 1906
Wait, John Cassan. Attorney at Law, Eng. Jurisprudence, 38 Park Row, New York City		Feb. 3, 1892
Waite, Guy Bennett. Mgr., Standard Concrete Steel Co., 31st-32d Sts., East River, New York City	Assoc. M. M.	May 2, 1894 Nov. 5, 1907
Waldo, Mark Albigence. Care, The Dominion Phosphate Co., Bartow, Fla		May 2, 1900
Waldron, Samuel Payson. Care, Am. Bridge Co., 30 Church St., New York City	Assoc. M. M.	Jan. 7, 1903 May 4, 1909
Walker, Clement Isaac. Chf. Engr., Empire City Subway Co. (Ltd.), 426 West 58th St., New York City	Assoc. M. M.	April 1, 1891 May 3, 1904
Walker, Elton David. Prof. of Hydr. and San. Eng., The Pennsylvania State Coll., and Cons. Engr., State College, Pa	Jun. Assoc. M. M.	Oct. 4, 1892 June 1, 1898 Sept. 5, 1900
Walker, Frank Hiram. 428 Liberty St., Franklin, Pa		Aug. 31, 1909
Walker, James Wilson Grimes. Civ. Engr., U. S. N., Naval Training Station, Newport, R. I.		Oct. 5, 1904
Walker, Jesse Wager. (Pittsburg Constr. Co.), Diamond National Bank Bldg., Pittsburg, Pa		May 7, 1884
Walker, John Simpson. U. S. Asst. Engr., Nashville, Tenn.		Jan. 5, 1881
Walker, Meriwether Lewis. Maj., Corps of Engrs., U. S. A., Custom House, Memphis, Tenn		Feb. 2, 1909
R. Wall, Edward Everett. Asst. Water Commr., 34 East Grand Ave., St. Louis, Mo		Feb. 1, 1905
Wallace, Harold Ulmer. 732 Pine St., Michigan City, Ind.		Dec. 7, 1904
R. WALLACE, JOHN FINDLEY. (*Past-President*). Pres., Electric Properties Co., 165 Broadway, New York City		June 2, 1886

		Date of Membership.
Wallace, John Herbert. Cons. Engr., 2414 Gough St., San Francisco, Cal		Jan. 2, 1890
Wallace, Joseph Harrison. Temple Court Bldg. (Res., 604 West 115th St.), New York City	Jun. Assoc. M. M.	Dec. 1, 1896 Dec. 1, 1897 Nov. 6, 1901
Walmsley, Walter Newbold. Care, N. W. Ashmead, 929 Chestnut St., Philadelphia, Pa		Dec. 1, 1908
Walsh, George Scherzer. Room 308, Richard Blk., Lincoln, Nebr	Jun. Assoc. M. M.	Feb. 2, 1897 May 1, 1901 Mar. 31, 1908
Walter, Raymond F. Superv. Engr., U. S. Reclamation Service, 423 Commonwealth Bldg., Denver, Colo		Oct. 5, 1909
Ward, Charles Dod. 702 St. Nicholas Ave., New York City		Mar. 3, 1869
Ward, Thomas Monroe. Chf. Engr. and Gen. Mgr., Canton R. R. and Md. & Penn. R. R., 24 Commerce St., Baltimore, Md		Mar. 7, 1906
Warner, Edwin Hall. Union Trust Bldg., Los Angeles, Cal	Assoc. M. M.	May 6, 1891 Oct. 4, 1893
Warner, Frank Charles. U. S. Asst. Engr., Delaware City, Del		Dec. 6, 1905
Warren, William Henry. Challis Prof. of Eng., Univ. of Sydney, Sydney, New South Wales, Australia		Feb. 5, 1890
Warrington, Harry Esmond. Cons. Engr., Eighth, near Pepper St., Riverside, Cal	Assoc. M. M.	April 6, 1898 Mar. 5, 1907
Washburn, Frank Sherman. 413 Keyser Bldg., Baltimore, Md.		Nov. 7, 1888
Wason, Leonard Chase. Pres. and Engr., Aberthaw Constr. Co., 8 Beacon St., Boston, Mass.	Assoc. M. M.	April 3, 1901 April 1, 1903
Waterhouse, John. 243½ York St., Jersey City, N. J		Oct. 4, 1899
Wathen, Benjamin Southern. Chf. Engr., Tex. & Pac. Ry., Dallas, Tex		Nov. 2, 1892
Watkins, Frederick William. Div. Engr., Aqueduct Comm.; Res., 45 Rockledge Ave., White Plains, N. Y		Oct. 3, 1883
Watkins, Richard. "Lynwood," Marrickville Rd., Marrickville, near Sydney, New South Wales, Australia		Dec. 3, 1890
Watson, Irvine. Engr., U. S. Reclamation Service, Sunnyside, Wash	Assoc. M. M.	June 3, 1903 Mar. 3, 1908
Watson, Wilbur Jay. 1328 Citizens Bldg., Cleveland, Ohio	Jun. Assoc. M. M.	Oct. 4, 1898 Jan. 2, 1901 Jan. 3, 1905
Watson, William. Secy., Am. Acad. of Arts and Sciences, 107 Marlborough St., Boston, Mass	Assoc. M.	Mar. 1, 1882 Sept. 2, 1891
Watson, William Parsons. 49 West 7th St., Columbia, Tenn.		June 1, 1887
Watt, David Alexander. Superv. Engr., N. Y. State Barge Canal, Albany, N. Y		Feb. 6, 1901
Watt, John Marshall Gilkison. Asst. Div. Engr., Corozal, Canal Zone, Panama		Feb. 5, 1902

		Date of Membership
Wauters, Carlos. Avenida de Mayo 878, Buenos Aires, Argentine Republic		Oct. 5, 1909
Webb, De Witt Clinton. Civ. Engr., U. S. N., Navy Yard, Boston, Mass		Sept. 6, 1905
Webb, George Herbert. Chf. Engr., Mich. Cent. R. R., Detroit, Mich		Feb. 1, 1893
Webb, Walter Loring. Cons. Engr., 1026 Real Estate Trust Bldg., Philadelphia, Pa	Assoc. M. M.	May 4, 1892 May 3, 1904
Weber, Alexander Hamilton. U. S. Asst. Engr., Colorado Bldg., Washington, D. C		Oct. 3, 1900
Webster, Albert Lowry. Cons. Engr., 82 Wall St., New York City	Jun. Assoc. M. M.	Sept. 6, 1882 June 3, 1891 April 6, 1909
Webster, Charles Edward. Cons. Engr., South Bethlehem, Pa.		Oct. 4, 1899
Webster, George Smedley. Chf. Engr. and Surv., Bureau of Surveys, City Hall, Philadelphia, Pa	Assoc. M. M.	Sept. 7, 1892 Oct. 4, 1893
Webster, William Richardson. Cons. and Insp. Engr., 411 Walnut St., Philadelphia, Pa		April 5, 1899
Weeks, William Charles. Contr. Engr., 404 Central Bldg., Seattle, Wash		Oct. 2, 1907
Wegmann, Edward. Cons. Engr., Aqueduct Comm., 280 Broadway, New York City		Mar. 7, 1888
Weinhagen, Fred. Pres., Wisconsin Bridge & Iron Co., 606 Colby & Abbott Bldg., Milwaukee, Wis		July 4, 1888
Weiskopf, Samuel C. Cons. Engr., 68 William St., New York City	Jun. M.	May 7, 1884 Dec. 5, 1888
Wells, Charles Edwin. Div. Engr., Board of Water Supply, City of New York, White Plains, N. Y		June 1, 1892
Wells, James Hollis. Civ. Engr. and Archt., 32 Nassau St., New York City		Feb. 5, 1901
Wells, Lawrence William. Asst. to Gen. Mgr. and Chf Engr., Tex. Midland R. R., Terrell, Tex		Dec. 5, 1906
Wendt, Edwin Frederick. Asst. Engr., Pitts. & Lake Erie R. R., Pittsburg, Pa		Oct. 7, 1903
Wentworth, Charles Chancellor. Prin. Asst. Engr., Norfolk & West. Ry., Roanoke, Va		April 4, 1888
Wenzell, Andrew Jackson. Cons. Engr., South Haven, Mich		Oct. 3, 1906
West, Charles Hunter. Chf. Engr., Mississippi Levee Dist., Greenville, Miss		Oct. 1, 1902
Westinghouse, George. Pittsburg, Pa		Jan. 7, 1891
Weston, Charles Valentine. Pres. and Gen. Mgr., So. Side Elev. R. R. Co., 935 East 49th St., Chicago, Ill		Sept. 5, 1900
Weston, Edmund Brownell. Cons. Engr.; Pres., Jewell Export Filter Co., 86 Weybosset St., Providence, R. I		Dec. 6, 1882

		Date of Membership.
Weston, George. Asst. Chf. Engr., Board of Superv. Engrs., Chicago Traction, 181 La Salle St., Chicago, Ill		June 5, 1907
Wetherbee, George Albert. Inglewood, Cal		April 5, 1893
Wetherill, William Chattin. Cons. Engr., The Empire Zinc Co., 703 Symes Bldg., Denver, Colo		Dec. 1, 1886
Weymouth, Frank Elwin. Superv. Engr., U. S. Reclamation Service, Boise, Idaho	Assoc. M. M.	Sept. 4, 1901 Feb. 5, 1907
Wheeler, Daniel Merrick. Railroad Insp., Mass. R. R. Comm., 230 Forest Park Ave., Springfield, Mass		Mar. 6, 1901
Wheeler, Ebenezer Smith. U. S. Asst. Engr., Detroit, Mich		Nov. 7, 1883
Wheeler, Edgar True. Engr., Mercereau Bridge & Constr. Co., 661 Pacific Elec. Bldg., Los Angeles, Cal		Dec. 7, 1904
Wheeler, Levi Lockwood. Asst. U. S. Engr., Sterling, Ill		June 4, 1884
Wheeler, William. Cons. Engr., 14 Beacon St., Boston, Mass		Oct. 4, 1893
Wheelock, De Forest Augustus. Civ. and San. Engr., City Bldg., Warren, Pa	Assoc. M. M.	Feb. 3, 1897 April 30, 1907
Whildin, William Gwilym. Supt., Western Div., Lehigh Coal & Nav. Co., Lansford, Carbon Co., Pa		May 6, 1908
Whinery, Samuel. Cons. Engr., 95 Liberty St., New York City	Jun. M.	April 1, 1874 May 4, 1881
Whipple, George Chandler. Cons. Engr., 103 Park Ave., New York City	Assoc. M. M.	Sept. 6, 1899 Oct. 6, 1908
Whistler, John T. Civ. and Hydr. Engr., Chamber of Commerce Bldg., Portland, Ore	Assoc. M. M.	Jan. 2, 1901 Oct. 7, 1903
White, George Howard. Asst. Engr., C., M. & St. P. Ry. (Res., 2709 Emerson Ave., South), Minneapolis, Minn		May 2, 1883
White, Henry Fisher. 5463 East End Ave., Chicago, Ill		Jan. 2, 1890
White, James Gilbert. Pres., J. G. White & Co., Inc., 43 Exchange Pl., New York City		Mar. 2, 1904
White, Timothy Sidney. Vice-Pres. and Chf. Engr., Penn Bridge Co., Beaver Falls, Pa		April 3, 1889
White, William MacIntire. Engr. with Am. Bridge Co., 30 Church St., New York City	Assoc. M. M.	Jan. 2, 1901 Mar. 2, 1909
Whitfield, James Edward. Min. Engr., 406 Locust St., Philadelphia, Pa		Mar. 2, 1904
Whitford, Reid. U. S. Asst. Engr., Georgetown, S. C		Dec. 2, 1896
Whitmer, David Heikes. Asst. Supt., Am. Pipe & Constr. Co., 112 North Broad St., Philadelphia, Pa		May 6, 1903
Whitney, Frank Ormond. Chf. of Surveying, Divs. of the Eng. and Street Laying-Out Depts., 25 Old Court House, Boston, Mass	Jun. M.	May 3, 1876 Jan. 5, 1887
WHITTEMORE, DON JUAN. (*Past-President*). Chf. Engr., C., M. & St. P. Ry. Co., 1345 Railway Exchange, Chicago, Ill. (Res., 222 Biddle St., Milwaukee, Wis.)		July 10, 1872

			Date of Membership.
	Whittemore, Walter Frank. 1 Newark St., Hoboken, N. J.	Jun. Assoc. M. M.	Mar. 6, 1889 April 6, 1892 Oct. 31, 1905
	Wickes, Edward Dana. Gen. Supt., Alma Cement Co., Wellston, Ohio	Assoc. M. M.	Dec. 3, 1902 Oct. 2, 1906
	Wiest, Julius Christian. Contr.; Gen. Mgr., Nicaragua R. R. and Steamer Line, Managua, Nicaragua		Feb. 5, 1902
	Wilcox, Frank. Engr. of The T. A. Gillespie Co., 800 Westinghouse Bldg., Pittsburg, Pa		Oct. 7, 1903
	Wiley, Andrew Jackson. Cons. Hydr. Engr., Boise, Idaho		Dec. 5, 1894
	Wiley, William Halsted. Scientific Publisher, 43 East 19th St., New York City		Feb. 17, 1869
R.	**Wilgus, William John.** 165 Broadway, New York City		April 1, 1896
	Wilkes, James Knapp. Chf. Engr., Board of Public Works, New Rochelle, N. Y.	Assoc. M. M.	June 3, 1891 April 3, 1906
	WILKINS, WILLIAM GLYDE. (*Director*). (The W. G. Wilkins Co., Engrs. and Archts.), Westinghouse Bldg., Pittsburg, Pa		Dec. 4, 1889
	Wilkinson, Thomas Lee. Cons. Mech. Engr., 213 Boston Bldg., Denver, Colo		Feb. 5, 1908
	Williams, Charles Page. Engr., U. S. Reclamation Service, Malta, Mont	Assoc. M. M.	Oct. 2, 1901 Nov. 1, 1904
	Williams, Chauncey Grant. Contr., Lynchburg, Va	Assoc. M. M.	Feb. 6, 1895 Oct. 7, 1903
	Williams, Cyrus John Richard. Engr., Lyttelton Harbour Board, Christchurch, New Zealand		Feb. 6, 1901
	Williams, David. Div. Engr., B. & M. R. R., St. Johnsbury, Vt.		May 4, 1898
	Williams, Edward Gilbert. Constr. Mgr., J. G. White & Co., Inc., 43 Exchange Pl., New York City		Feb. 3, 1897
	Williams, Friend Pitts. Res. Engr., N. Y. State Barge Canal, 352 Guy Park Ave., Amsterdam, N. Y.		July 1, 1909
N.	**WILLIAMS, GARDNER STEWART.** (*Director*). Civ. Engr., and Prof. of Civ., Hydr. and San. Eng., Univ. of Michigan, Room 207 New Engineering Bldg., Ann Arbor, Mich	Assoc. M. M.	Oct. 2, 1895 Dec. 6, 1899
	Williams, Samuel Daugherty, Jr. Care, Office of Engr., Grade Separation, Mich. Cent. R. R., Detroit, Mich	Assoc. M. M.	Dec. 2, 1903 Jan. 7, 1908
	Williams, William Fish. City Engr., S. E. Cor. Court and Orchard Sts., New Bedford, Mass		April 4, 1906
	Williamson, Francis Stuart. Cons. Engr., 84 William St., New York City		Sept. 7, 1887
	Williamson, Frank Robert. Asst. Engr., San. Dist. of Chicago, 1500 Am. Trust Bldg., Chicago, Ill		Nov. 7, 1906

		Date of Membership.
WILLIAMSON, SYDNEY BACON. Div. Engr., La Boca Locks, Panama Canal, Corozal, Canal Zone, Panama	Assoc. M. M.	Jan. 3, 1894 Dec. 2, 1896
WILLIS, PAUL. Secy. and Engr., Kenwood Bridge Co., 4857 Madison Ave., Chicago, Ill		Oct. 2, 1901
WILLOUGHBY, JULIUS EDGAR. Engr. of Constr., L. & N. R. R., 9th and Broadway, Louisville, Ky		June 1, 1909
WILSON, CHARLES ALFRED. 529 Burns Ave., Station R, Cincinnati, Ohio		April 1, 1891
WILSON, CHARLES BEATTY. Supt., Foster-Creighton-Gould Co., 762½ Asylum Ave., Knoxville, Tenn		Dec. 2, 1903
WILSON, CHARLES COKER. 1302 Main St., Columbia, S. C.		Dec. 4, 1907
WILSON, CHARLES WILLIAM SCHRAGE. Wilson & English Constr. Co., New Rochelle, N. Y.	Jun. Assoc. M. M.	April 5, 1892 Jan. 3, 1900 June 6, 1905
WILSON, ELLIOTT HINCKLEY. Civ. and Min. Engr. (Receiver of the Minnie Healey Mine), Butte, Mont		Feb. 1, 1888
WILSON, EVERETT BROOMALL. Secy. and Treas., The Am. Bureau of Inspection and Tests, Monadnock Blk., Chicago (Res., 423 Greenleaf St., Evanston), Ill	Assoc. M. M.	Mar. 4, 1903 Dec. 6, 1904
WILSON, GEORGE LEVERETT. Engr., M. of W., Twin City Rap. Trans. Co., Minneapolis, Minn		Feb. 5, 1890
WILSON, HENRY FELIX, JR. Cons. Engr., 417 Empire Bldg., Birmingham, Ala	Assoc. M. M.	April 2, 1902 May 2, 1905
WILSON, HENRY WILLIAM. Archt. and Cons. Engr. (Wilson, Harris & Richards), 1060 Drexel Bldg., Philadelphia, Pa.		Sept. 6, 1876
WILSON, HERBERT MICHAEL. Chf. Engr., U. S. Geological Survey, Washington, D. C	Jun. M.	Sept. 5, 1883 Jan. 2, 1890
WILSON, PERCY HARTSHORNE. Cons. Engr., 1330 Land Title Bldg., Philadelphia, Pa	Jun. Assoc. M. M.	Jan. 2, 1900 Feb. 5, 1902 Oct. 5, 1909
WILSON, WINTER LINCOLN. Prof. of Railroad Eng., Lehigh Univ., South Bethlehem (Res., 29 Market St., Bethhem), Pa		May 1, 1901
WIMMER, SEBASTIAN. R. F. D. No. 1, Albany, Stearns Co., Minn		Mar. 2, 1881
WINDSOR, PHILIP BRUNDAGE. 1 Madison Ave., New York City		July 1, 1909
WING, CHARLES BENJAMIN. Prof. of Structural Eng., Stanford Univ., 345 Lincoln Ave., Palo Alto, Cal	Assoc. M. M.	Nov. 4, 1896 Nov. 2, 1908
WINGFIELD, NISBET. Cons. Engr. for Hydr., Sewerage and Municipal Lighting Plants, Augusta, Ga		May 1, 1895
WINSLOW, BENJAMIN EMANUEL. Cons. Architectural Engr., 1527 North California Ave., Wicker Park Station, Chicago, Ill		Oct. 2, 1907

		Date of Membership.
Winsor, Frank Edward. Div. Engr., Board of Water Supply, City of New York, Realty Bldg., White Plains, N. Y.	Assoc. M. M.	Nov. 4, 1903 Dec. 5, 1905
Wise, Colin Reed. City Surv. and Supt., Sewers, 34 Bloomfield Ave., Passaic, N. J.		April 6, 1904
Wisner, George Monroe. Chf. Engr., San. Dist. of Chicago, 1500 Am. Trust Bldg., Chicago, Ill.		Feb. 4, 1903
Witmer, Francis Potts. Engr. in Chg. of Bridge Designing and Estimating, Am. Bridge Co., 30 Church St., New York City (Res., 32 Mulford St., East Orange, N. J.)		Nov. 30, 1909
Witmer, Joseph Franklin. Hydr. and San. Engr., Chapin Blk., Swan and Pearl Sts., Buffalo, N. Y.		May 4, 1904
Witt, Carlton Carpenter. Engr., South Dakota R. R. Comm., Sioux Falls, S. Dak.		April 6, 1909
Woermann, John William. Asst. Engr., Western Div., U. S. A., 428 Custom House, St Louis, Mo.	Assoc. M. M.	May 1, 1895 May 7, 1902
Wolf, Julius Herman George. Pres. and Mgr., North Am. Exploration Co., 1023 Mills Bldg., San Francisco, Cal.	Assoc. M. M.	May 7, 1902 April 5, 1904
Wolfe, Christian John. 525 Fifty-eighth St., Brooklyn, N. Y.		Mar. 6, 1907
Wölfel, Paul Ludwig. Chf. Engr., McClintic-Marshall Constr. Co., Pittsburg, Pa.	Jun. Assoc. M. M.	July 3, 1889 July 1, 1891 Nov. 6, 1895
Wolstenholme, Albert. 22 Bedford St., Fall River, Mass.		June 6, 1906
Wolverton, Irving Mason. Chf. Engr., The Mt. Vernon Bridge Co., Mt. Vernon, Ohio	Assoc. M. M.	Dec. 4, 1895 Dec. 1, 1903
Wood, Alvinus Brier. Mgr. and Secy., Ore. & Southeast. R. R. Co., Cottage Grove, Ore.		Sept. 6, 1905
Wood, Charles Widney. 315 Carondelet St., New Orleans, La.		Oct. 7, 1908
Wood, Edward Nathan. 1003 Manhattan Bldg., Chicago, Ill.		Dec. 5, 1906
Wood, Frederic James. Insp., Elev. and Subway Constr., Boston Elev. Ry., Foxboro, Mass.		Dec. 6, 1905
Wood, Henry Beecher. Asst. Engr., Harbor and Land Comm., Room 134, State House, Boston, Mass.		April 3, 1895
Wood, Henry Shotwell. Room 1825 Park Row Bldg., New York City		May 1, 1907
Wood, Irving Sparrow. Asst. Engr. in Chg., Water Dept., City Engr.'s Office, City Hall, Providence, R. I.	Jun. Assoc. M. M.	Mar. 5, 1890 Mar. 7, 1900 Mar. 6, 1906
Wood, Joseph. First Vice-Pres., Penn. Lines, 909 Union Station, Pittsburg, Pa.		April 1, 1874
Wood, Warren Powell. Chf. Engr., Central Idaho Development Co., Ltd., Lewiston & Southeastern Elec. Ry. Co., Ltd., Salmon River Power Co., Ltd., Elec. Ry. Townsite Co., Nezperce & Idaho R. R. Co. and Idaho & Northwestern R. R. Co., Box 38, Lewiston, Idaho		July 10, 1907

	Date of Membership.	
WOODARD, SILAS H. (Noble & Woodard, Civ. and Cons. Engrs.), 7 East 42d St., New York City	Assoc. M. M.	Jan. 2, 1901 Nov. 1, 1904
WOODBURY, CHARLES JEPTHA HILL. Cons. Engr., 45 Milk St., Boston, Mass		Dec. 3, 1884
WOODMAN, ANDREW WHITNEY. 108 La Salle St., Chicago, Ill.		Oct. 4, 1905
WOODRUFF, EDWARD LOWREY. The Burlington, Los Angeles, Cal		Oct. 3, 1900
WOODS, HENRY DICKINSON. 99 Highland St., West Newton, Mass	Assoc. M. M.	Mar. 1, 1893 June 5, 1895
VOODS, ROBERT PATTERSON. Cons. Engr., 801 Traction Terminal Bldg., Indianapolis, Ind	Jun. Assoc. M. M.	Feb. 2, 1897 Mar. 7, 1900 April 1, 1903
WOODWORTH, ROBERT BELL. Engr., Carnegie Steel Co., 427 Carnegie Bldg., Pittsburg, Pa		April 1, 1908
WOOLDRIDGE, CHARLES LAWSON. Superv. Engr., The T. A. Gillespie Co., 125 South Lang Ave., Pittsburg, Pa		Oct. 5, 1909
WOOLLEY, ANDREW FEASTER. Supt., Empire Eng. Corporation, Sylvan Beach, N. Y		Dec. 2, 1903
VOOTEN, WILLIAM PRESTON. Capt., Corps of Engrs., U. S. A., West Point, N. Y	Assoc. M. M.	May 3, 1905 Mar. 31, 1908
VORCESTER, JOSEPH RUGGLES. Cons. Engr., 79 Milk St., Boston, Mass		Jan. 2, 1895
VORTHINGTON, CHARLES. Engr. and Archt., 229 West 101st St., New York City	Assoc. M. M.	Dec. 1, 1897 Nov. 6, 1901
VRENTMORE, CLARENCE GEORGE. Care, Bureau of Public Works, Manila, Philippine Islands	Assoc. M. M.	April 5, 1905 Oct. 5, 1909
VRIGHT, AUGUSTINE WASHINGTON. Cons. Engr., Pomona, Cal.		May 5, 1886
VRIGHT, CHARLES HERBERT. Chf. Engr., Brown Hoisting Machinery Co., Cleveland, Ohio		Oct. 5, 1892
VRIGHT, EDWARD THOMAS. 690 Pacific Elec. Bldg., Los Angeles, Cal		Feb. 3, 1886
VRIGHT, JOSEPH. Engr., U. S. Reclamation Service, Glendive, Mont	Assoc. M. M.	Dec. 7, 1904 Aug. 31, 1909
VRIGHT, JOSEPH BODINE. Associate Cons. Engr., Bondholders Committee, 3d Ave. R. R. Reorganization, 165 Broadway, No. 1410, New York City	Assoc. M. M.	June 2, 1897 Jan. 31, 1905
VRIGHT, WILLIS BENTON. Engr., Sewerage and Water Board, 501 City Hall, New Orleans, La		Nov. 3, 1897
VROTNOWSKI, ARTHUR FRANCIS. Tampico Nav. Co., Ganahl, San Luis Potosi, Mexico		July 12, 1877
AMAGUCHI, JUNNOSUKE. Director of M. of W. Dept., Imperial Govt. Railways, Tokyo, Japan		Mar. 4, 1903

		Date of Membership.
YATES, PRESTON KING. Chf. Engr., Tomkins Cove Stone Co., Tomkins Cove, N. Y.	Jun. M.	June 6, 1883 April 5, 1893
YEATMAN, CHARLES POPE. Mgr., Barranquilla Ry. & Pier Co., Barranquilla, Colombia		Feb. 2, 1887
YEATMAN, MORGAN EDWARD. Cons. Civ. Engr., Parliament Mansions, Victoria St., London, S. W., England		May 4, 1892
YEATMAN, POPE. Gen. Mgr. and Cons. Engr., Guggenheim Exploration Co., 165 Broadway, Room 1714, New York City		Oct. 4, 1893
YEREANCE, WILLIAM BURNET. Cons. Engr., 128 Broadway, New York City	Jun. Assoc. M. M.	May 3, 1892 Dec. 2, 1896 Mar. 3, 1908
YONGE, SAMUEL HUMPHREYS. U. S. Asst. Engr. in Chg. of Impvt., James River, Va., 28 North 9th St., Richmond, Va.		May 5, 1880
C. YORK, HERBERT WALDO. Cons. Engr., Am. Smelting & Refining Co., 165 Broadway, New York City	Jun. M.	May 2, 1888 June 3, 1896
YOUNG, ROSCOE CYPRIAN. Chf. Engr., Munising Ry., Marquette & South Eastern Ry., Lake Superior & Ishpeming Ry., Marquette, Mich.		Oct. 1, 1902
YUILLE, NATHANIEL ALSTON. Asst. Engr., U. S. Engr. Office, Box 709, Mobile, Ala.	Assoc. M. M.	June 6, 1906 Nov. 8, 1909
ZARBELL, ELMER. Office, Chf. Engr., L. & N. R. R. Co., Louisville, Ky.	Jun. Assoc. M. M.	Jan. 3, 1899 Feb. 7, 1900 May 5, 1908
ZESIGER, ALBERT WILLIAM. 216 City Hall, Cleveland, Ohio		Aug. 31, 1909
ZIESING, AUGUST. Pres., Am. Bridge Co., 115 Adams St., Room 1324, Chicago, Ill.		Oct. 5, 1898
ZIFFER, EMANUEL A. Pres. of the Council of Adm. of the Imp. Royal Privileged Lemberg-Czernowitz-Jassy Ry. Co., I Opernring 5, Vienna, Austria		June 7, 1893
ZINN, AARON STANTON. Res. Engr., Panama Canal, Empire, Canal Zone, Panama		Oct. 5, 1909
ZINN, GEORGE ARTHUR. Lt.-Col., Corps of Engrs., U. S. A., 537 Congress St., Portland, Me.		Feb. 3, 1904
ZOLLINGER, LUTHER REESE. Engr., M. of W., P. R. R., Broad St. Station, Philadelphia, Pa.		Mar. 6, 1901
ZOOK, MORRIS ALEXANDER. Civ. and Cons. Engr., 1467 Hudson Terminal, New York City (Res., 123 East 6th St., Plainfield, N. J.)		Oct. 4, 1899

Members, 2 582.

ASSOCIATE MEMBERS.

[Assoc. M. Am. Soc. C. E.]

		Date of Membership.
ABELLA, JUAN. Cons. Engr., Parliament Mansions, Victoria St., Westminster, London, S. W., England		Jan. 6, 1897
ACKENHEIL, ALFRED CURTIS. Asst. Engr., T. A. Gillespie Co., 3423 Webster Ave., Pittsburg, Pa		April 6, 1909
ACKERMAN, ALEXANDER SEYMOUR. Asst. Engr., Cape Cod Constr. Co., Sandwich, Mass	Jun. Assoc. M.	April 30, 1907 April 6, 1909
ADAMS, ARTHUR. Asst. Hydr. Engr., J. G. White & Co., 43 Exchange Pl., New York City	Jun. Assoc. M.	Oct. 1, 1901 April 6, 1904
ADAMS, EDWARD MAGUIRE. Capt., Corps of Engrs., U. S. A., U. S. Engr. Office, Charleston, S. C.	Jun. Assoc. M.	Oct. 7, 1902 Jan. 3, 1906
ADAMS, EVERETT EUGENE. Asst. to Cons. Engr., Union Pacific and Southern Pacific Systems, 135 Adams St., Chicago, Ill		April 1, 1908
ADAMS, RAYMOND EDMOND. Civ. Engr., Quarter Master General's Office, Lemon Bldg., Washington, D. C	Jun. Assoc. M.	May 1, 1900 Dec. 6, 1905
ADDISON, CHARLES LAMBERT. Asst. to Pres., Long Island R. R. Co., Long Island City, N. Y		May 1, 1907
ADEY, WILLIAM HENRY. Asst. Engr., D. & H. Co., Albany (Res., 181 Main St., Cohoes), N. Y.	Jun. Assoc. M.	Feb. 4, 1896 Dec. 3, 1902
ADGATE, FREDERICK WHITNEY. Western Mgr., The Foundation Co., 419 Rookery Bldg., Chicago, Ill		Jan. 6, 1904
AGRAMONTE, ALBERT ARTHUR. Care, Francisco Etchevarne, 871 Venezuela, Buenos Aires, Argentine Republic		Oct. 7, 1908
AIKENHEAD, JAMES RAY. With Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City		Feb. 7, 1906
ALBREE, RALPH. 1112 Western Ave., Allegheny, Pa.	Jun. Assoc. M.	Oct. 4. 1898 Oct. 1, 1902
ALDERSON, ALGERNON BROWN. Town Engr., West Hartford, Conn		Oct. 2, 1907
ALEXANDER, HENRY JAMES. 23 Flatbush Ave., Brooklyn, N. Y.		Mar. 7, 1906
ALEXANDER, JOHN HOWARD. 4425 Delmar Ave., St. Louis, Mo.		May 4, 1909
ALEXANDER, KAY. Asst. Engr., N. P. Ry., Edgeley, N. Dak		Oct. 2, 1907
ALEXANDER, ROBERT LEE. Asst. Engr., N. P. Ry., Edgeley, N. Dak	Jun. Assoc. M.	Nov. 1, 1904 Dec. 5, 1906
ALLAN, ALEXANDER GEORGE. Chf. Engr., Antlers Orchard Development Co., 1340 Garfield St., Denver, Colo		Mar. 6, 1901

		Date of Membership.
Allardice, Elliot Ritchie Barclay. Supt., Wachusett Dept., Met. Water-Works, Clinton, Mass		Dec. 6, 1905
Allen, Charles Metcalf. Prof. of Hydr. Eng., Worcester Poly. Inst., Worcester, Mass		June 1, 1904
Allen, Eugene Yorke. Care, Am. Ry. Supply Co., 24 Park Pl., New York City		Dec. 6, 1905
Allen, Frank William. White Plains, N. Y	Jun. Assoc. M.	Nov. 3, 1896 May 4, 1898
Allen, John Lee. Secy., J. L. Fulton & Co., 502 Monadnock Blk., Chicago, Ill		Nov. 1, 1905
Allen, Robert Livingston. Care, Archbold-Brady Co., Syracuse, N. Y		May 6, 1908
Allen, William Frederick. Gen. Secy., Am. Ry. Assoc., 24 Park Pl., New York City		Jan. 3, 1900
Allison, Calvin Tomkins. Gen. Contr., Jones Bldg., Haverstraw, N. Y		May 1, 1907
Alsberg, Julius. 56 West 95th St., New York City		June 3, 1908
Altstaetter, Frederick William. P. O. Box 75, Wheeling, W. Va		Nov. 6, 1907
Amburn, William Wesley. Locating Engr., C. M. & P. S. Ry., Montavilla Station, Portland, Ore		Sept. 2, 1908
Ames, George Marshall. Contr. (Hauser, Owen & Ames), 102 Ottawa St., Grand Rapids, Mich		June 7, 1899
Ammann, Othmar Hermann. Wissahickon, Philadelphia, Pa		Jan. 8, 1908
Anderson, Charles Louis Bates. (Hazlehurst & Anderson, Cons. Mun. Engrs.), P. O. Box 513, Wilmington, N. C		May 6, 1908
Anderson, David Guy. Chf. Engr., Blackstaff Eng. Co., 1332 Walnut St., Philadelphia, Pa		Oct. 4, 1899
Anderson, Robert Harlow. Care, J. G. White & Co., 43 Exchange Pl., New York City		Jan. 8, 1908
Anderson, William Townsend. The Judson, Washington Sq., New York City		June 5, 1907
Andros, Frederic William. "La Sauteña," Colombres, Tamaulipas, Mexico		Feb. 1, 1899
Anthony, Walter Loring. Engr. in Chg., Providence Office, The R. H. Tingley Co., 75 Westminster St., Providence, R. I	Jun. Assoc. M.	Jan. 5, 1904 Mar. 7, 1906
Arce, Julius Andrew. Apartado 90, Arequipa, Peru		Aug. 31, 1909
Archer, Augustus Rowley. Engr., Sales Dept., Carnegie Steel Co., Pittsburg, Pa		April 4, 1906
Archibald, Warren Martin. Res. Engr. for Ford, Bacon & Davis, Care, Houston Lighting & Power Co. 1905, 1502 Commerce St., Houston, Tex		May 2, 1906
Arend, Albert Cornelius. Cons. Hydr., Municipal and Reinforced Concrete Engr., Brandeis Bldg., Omaha, Nebr		Feb. 2, 1909

		Date of Membership.
Armitage, George Washington. Supt. of Constr., Army Transport Docks and Seawall, Ft. Mason, San Francisco, Cal		April 2, 1902
Armour, Charles Webster L. Fort Smith, Ark		June 1, 1904
Armstrong, Alexander Floyd. Chf., Bureau Research, State Dept. of Highways, Albany, N. Y	Jun. Assoc. M.	Oct. 7, 1902 Nov. 1, 1905
Armstrong, Charles Johnstone. Dist. Engr., Central South African Rys., Bloemfontein, Orange River Colony, South Africa		June 6, 1906
Armstrong, Robert Stuart. Chf. Engr., Brooklyn Plant, Empire Bridge Co., Ft. of Clay St., Brooklyn, N. Y		Feb. 6, 1907
Armstrong, Roger Wellington. Asst. Designing Engr., N. Y. Board of Water Supply, 299 Broadway, New York City		Nov. 8, 1909
Arn, William Godfrey. Asst. Engr., Ill. Cent. R. R., 7th St. Union Depot, Louisville, Ky	Jun. Assoc. M.	Oct. 2, 1900 April 6, 1909
Arnott, Robert Fleming. Cons. Engr., 95 Liberty St., New York City		Mar. 2, 1909
Ash, Dorsey. Secy. and Treas., North American Exploration Co., 1023 Mills Bldg., San Francisco, Cal		June 3, 1903
Ash, Louis Russell. 309 Keith & Perry Bldg., Kansas City, Mo		Dec. 5, 1906
Atkins, Harold Bedford. Engr. and Accountant, 154 Nassau St., New York City		April 2, 1902
Atkinson, Asher. 1 Madison Ave., New York City (Res., 49 Mine St., New Brunswick, N. J.)		April 5, 1905
Atterbury, Charles De La Plane. City Engr., Centralia, Wash		Nov. 8, 1909
Atwood, Edward Franklin. Designing Engr., Eastern Concrete Constr. Co., 101 Tremont St., Boston (Res., 90 Crest Ave., Beachmont), Mass		June 5, 1907
Atwood, Thomas Clark. Div. Engr., Board of Water Supply, 299 Broadway, New York City (Res., 207 Woodworth Ave., Yonkers, N. Y.)		April 3, 1907
Atwood, William Greene. Chf. Engr., L. E. & W. R. R., Indianapolis, Ind		July 10, 1907
Avakian, John Caspar. Civ. and Hydr. Engr.; Pres. and Chf. Engr., Riverside Groves & Water Co., 631 Central Bldg., Los Angeles, Cal		July 9, 1906
Aylett, Philip. Prin. Asst. Engr., St. Louis Municipal Bridge, 4001 A Connecticut St., St. Louis, Mo		June 3, 1896
Babcock, William Stuart. Civ. and Waterproofing Engr., 17 Battery Pl., New York City		Feb. 1, 1905
Babé, Joseph Manuel. Second Chf. Engr. of Havana Province, Dept. of Public Works, Hy 19 Vedado, Havana, Cuba	Jun. Assoc. M.	May 31, 1904 Feb. 6, 1907

		Date of Membershi
Backes, William James. Chf. Engr., Central New England Ry., 59 Spruce St., Hartford, Conn	Jun. Assoc. M.	May 31, 190 July 9, 190
Baeta-Neves, Lourenco. Chf. Engr., Technical Dept. of Railways, Public Works and Industries, Bello Horizonte, Minas Geraes, Brazil		Nov. 30, 190
Bake, William Sibson. Asst. Engr., G. R. & I. Ry., Office of Chf. Engr., Grand Rapids, Mich		Jan. 4, 191
Baker, Elisha Brown. Contr., Herkimer, N. Y		April 1, 189
Baker, Harold James Manning. Junior Engr., U. S. Engr.'s Office, P. O. Box 1809, Seattle, Wash	Jun. Assoc. M.	Oct. 7, 190 Mar. 4, 190
Baker, Henry Erskine. Engr. and Const. Supt. of the Chinese Paper Mills, Hankow, China		May 7, 190
Baker, Hugh Cossart, Jr. (Baker & Jordahl, Contr. Engrs.), Confederation Life Chambers, Toronto, Ont., Canada		May 4, 190
Baker, Percival Stevens. Computer, P. & R. Ry., 520 Reading Terminal, Philadelphia, Pa	Jun. Assoc. M.	Sept. 4, 190 Oct. 2, 190
Baker, Sheldon King. Asst. Engr., U. S. Reclamation Service, Phœnix, Ariz	Jun. Assoc. M.	June 5, 190 Mar. 4, 190
Balch, Leland Rella. Care, U. S. Reclamation Service, Neillsville, Wis		Oct. 5, 19
Baldwin, George Herbert. 2610 Shattuck Ave., Berkeley, Cal		Jan. 8, 19
Baldwin, Hiram Ellsworth. 10532 Earle Ave., Cleveland, Ohio		Jan. 2, 18
Ball, Laurence Adams. Chf. Draftsman, Hay Foundry & Iron Works, Newark, N. J	Jun. Assoc. M.	May 3, 19 Feb. 6, 19
Ballou, Henry Welcome. 735 Banigan Bldg., Providence, R. I		Nov. 7, 19
Balz, Louis Christian Frederick. 964 S. High St., Columbus, Ohio		Feb. 5, 19
Bamford, William Brokaw. Archt. and Structural Engr., Cor. Chestnut and Hamilton Ave., Trenton, N. J	Jun. Assoc. M.	June 2, 19 Oct. 5, 19
Bance, Charles William. Pres., Cement Paving & Constr. Co., 1 Montgomery St., Jersey City, N. J		Mar. 5, 19
Bandy, James Marcus. Cons. Hydr. and San. Engr., Greensboro, N. C		Feb. 4, 1
Banks, George Hill. U. S. Engr. Office, Houghton, Mich		Sept. 4,
Banks, John Edwin. Engr., Bureau of Standards, Am. Bridge Co., Ambridge, Pa		June 4
Bannister, Carl Lincoln. Asst. Engr., Barge Canal Office, Rome, N. Y		May
Bantel, Edward Christian Henry. Adjunct Prof. of Civ. Eng., Univ. of Texas, 2307 San Antonio St., Austin, Tex		Feb.

		Date of Membership.
ARKER, CHARLES WHITNEY TILLINGHAST. Pres., Field, Barker & Underwood, Inc., Engrs. and Contrs., 718 Arcade Bldg., Philadelphia, Pa. .	Jun. Assoc. M.	June 6, 1905 June 1, 1909
ARKMANN, ERNST HENRY. Care, Mo. Val. Bridge & Iron Co., Leavenworth, Kans.		Oct. 7, 1908
ARLOW, DE WITT DUKES. Engr., Atlantic, Gulf & Pacific Co., 1132 Gresham Rd., Plainfield, N. J.		Feb. 7, 1906
ARLOW, JOHN SADLER. Asst. Engr., Ariz. East. R. R., Phœnix & East. R. R. and Ariz. & Colo. R. R., 35 Trust Bldg., Globe, Ariz.		May 6, 1908
ARNARD, WILFRED KEEFER. Engr., M. of W. and Structures, Pacific Elec. Ry. Co., 6th and Main Sts., Los Angeles, Cal.		Nov. 8, 1909
ARNES, FRED ASA. Asst. Prof., Ry. Eng., Cornell Univ., Ithaca, N. Y.		Dec. 7, 1904
ARNES, WALTER ESMOND. 32 Lincoln St., Malden, Mass.	Jun. Assoc. M.	May 6, 1902 Dec. 6, 1905
ARNES, WILLIAM THOMAS. With Metcalf & Eddy, 14 Beacon St., Boston (Res., 57 Grafton St., Newton Center), Mass.		Sept. 7, 1898
ARNETT, ROBERT CRARY. Cons. Engr., 510 Kansas City Life Bldg., Kansas City, Mo.		Dec. 5, 1900
ARNEY, PERCY CANFIELD. Prin. Asst. Engr., Board of Water Supply, 299 Broadway, New York City.	Jun. Assoc. M.	Mar. 3, 1896 June 5, 1901
ARR, JOSEPH CARROLL. Mine Operator (Barr, Gloninger & Walsh), Webb City, Mo.		Jan. 4, 1899
ARRATT, SYDNEY ALFRED. Supt., Ponupo Manganese Co., Santiago de Cuba, Cuba.		April 1, 1908
ARTELL, MAX JOHN. Asst. Engr., City Engr.'s Office, Hewes Bldg., San Francisco, Cal.	Jun. Assoc. M.	May 1, 1906 Oct. 5, 1909
ARTOCCINI, ASTOLFO. 55 Duane St., New York City.		May 6, 1903
ARTON, CALVIN LEWIS. Vice-Pres., McHarg-Barton Co., Contrs., 165 Broadway, New York City.		April 4, 1906
ARTON, WALTER CHEW. 3338 St. Charles Ave., New Orleans, La.		July 1, 1908
ASCOME, WESTERN RADFORD. Res. Engr., Manhattan Bridge, Brooklyn, 272 Manhattan Ave., New York City.	Jun. Assoc. M.	Dec. 3, 1891 May 5, 1897
SS, FREDERIC HERBERT. Engr., Minnesota State Board of Health; Asst. Prof. of Municipal & San. Eng., Univ. of Minnesota, Minneapolis, Minn.		Nov. 6, 1907
LL, GUY MANNERING. 741 Mulberry St., Clarksburg, W. Va.		Feb. 6, 1907
TT, ROBERT JAY. 1717 Forty-fourth St., Brooklyn, N. Y.	Jun. Assoc. M.	Feb. 3, 1903 Feb. 3, 1904
ELDER, BENJAMIN FRANKLIN. Potsdam, N. Y.		Jan. 4, 1910

		Date of Membershi
Bates, William Bernard. Cons. Engr. (Huggins & Bates), 6th Floor, Strickland Bldg., Roanoke, Va		Nov. 6, 190
Baum, Frank George. Cons. Elec. and Hydr. Engr., Chronicle Bldg., San Francisco, Cal		July 9, 190
Bausher, Carmi Irving. Asst. Engr., B. & C. Dept., The Penna. Steel Co., Steelton; Address, 136 North 13th St., Harrisburg, Pa		Dec. 7, 189
Baxter, David Elder. 32 West 60th St., New York City	Jun. Assoc. M.	May 2, 189 July 9, 190
Bayley, Charles Abercrombie Dunbar. 397 Amity St., Flushing, N. Y		Dec. 1, 190
Baylis, Arthur Raymond. Motive Power Dept., Interborough Rap. Tran. Co., 59th St. Power House, New York City		June 6, 190
Beach, James George. 423 Worcester Bldg., Portland, Ore	Jun. Assoc. M.	Aug. 31, 189 Sept. 2, 190
Beach, William Nicholas. 26 Cortlandt St., New York City		July 1, 190
Beal, George Safford. Res. Engr., Lake Altoona, 1810 Thirteenth St., Altoona, Pa		June 6, 190
Beale, Carroll. (Beale & Meigs), Washington Loan & Trust Bldg., Washington, D. C		Oct. 5, 190
Beale, Harry Orlando. Care, U. S. Reclamation Service, Fort Shaw, Mont		Oct. 5, 190
Bebb, Edward Crosby. Whitewater, Wis		Nov. 6, 190
Becker, Sylvanus A. Instr. in Civ. Eng., Lehigh Univ., 102 North St., Bethlehem, Pa	Jun. Assoc. M.	Dec. 1, 190 Feb. 5, 190
Beekman, John Vanderveer, Jr. Gen. Mgr., Whidden & Co., Inc., 155 Milk St., Boston, Mass	Jun. Assoc. M.	Sept. 3, 190 July 10, 190
Beer, Paul. Mgr., The Barber Asphalt Pav. Co., Des Moines, Iowa		Oct. 4, 190
Beeson, Alexander Conn. 14 Lincoln Ave., Crafton, Pa		May 1, 190
Begien, Ralph Norman. Div. Engr., B. & O. R. R., Philadelphia, Pa		June 7, 190
Belcher, Wallace Edward. Structural Engr., H. M. Byllesby & Co., Inc., Am. Trust Bldg., Chicago, Ill	Jun. Assoc. M.	Dec. 2, 190 June 3, 190
Belknap, Francis Wheelwright. Secy., Phœnix Constr. Co., 41 Park Row, New York City		Feb. 1, 190
Bell, Alfred Carroll. Contr. Engr., Wisconsin Bridge & Iron Co., 605 Colby-Abbot Bldg., Milwaukee, Wis	Jun. Assoc. M.	May 2, 189 Jan. 2, 190
Bellows, Daniel Everett. Asst. Engr., N. Y. State Barge Canal, 352 Guy Park Ave., Amsterdam, N. Y	Jun. Assoc. M.	April 30, 1907 July 1, 190
Bennett, Charles Noble. 101 Phillips Ave., Mt. Oliver Station, Pittsburg, Pa		Dec. 4, 1907

		Date of Membership.
Benson, Newton Davis. Engr. and Contr., 8 Dawson St., Providence, R. I.		July 10, 1907
Bergendahl, Gustave Storm. Civ. and Contr. Engr., 1432 Syndicate Trust Bldg., St. Louis, Mo.		April 3, 1907
Berger, Bernt. Cons. Engr., 45 Broadway, New York City.		April 5, 1893
Berger, John. Asst. Engr., N. Y. C. & H. R. R. R., 335 Madison Ave., New York City.		Oct. 2, 1907
Berry, Claude. Thomson, Carroll Co., Ill.		Feb. 6, 1907
Berry, Francis Rigdon. Care, Wichita Water Co., Wichita, Kans.	Jun. Assoc. M.	Dec. 2, 1902 Nov. 8, 1909
Berry, Leslie Graham. Contr. Engr., Des Moines Bridge & Iron Works (Res., 1521 Sixth Ave.), Des Moines, Iowa.		Dec. 1, 1908
Best, John Henry. Pres. and Gen. Mgr., Best Constr. Co., Wapato, Wash.		June 1, 1904
Betts, Edward Everett. Engr., Chickamauga and Chattanooga National Military Park, Chattanooga, Tenn.		April 5, 1899
Beugler, Charles Ernest. 6509 Wheeler St., Oakland, Cal.		Oct. 2, 1907
Bieler, Alphonsos Henry. Engr. of Bldg. Constr. with Horace Trumbauer, Archt., 200 Fifth Ave., New York City.		June 7, 1905
Bilger, Harry Edmund. Care, State Highway Comm., Springfield, Ill.		Aug. 31, 1909
Billingsley, James Wartelle. 705 Hibernia Bank Bldg., New Orleans, La.		May 6, 1908
Bischoff, Julius Montgomery. Asst. Engr., Terminal R. R. Assoc., Union Station (Res., 2736 Ann Ave.), St. Louis, Mo.		Jan. 4, 1910
Bissell, Clinton Talcott. Structural and Elec. Engr., National Board of Fire Underwriters, 135 William St., New York City.		Dec. 5, 1906
Blaauw, Geert. Asst. Engr. with F. S. Pearson, 25 Broad St., 20th Floor, New York City.		Nov. 30, 1909
Black, Edward Fryling. Instr. in Civ. Eng., Anglo-Chinese Coll., Foo Chow, China.	Jun. Assoc. M.	Oct. 31, 1905 Nov. 4, 1908
Black, Gurdon Gilmore. First Asst. Engr., Supply and Purifying Div., St. Louis Water Dept., 34 E. Grand Ave., St. Louis, Mo.		Oct. 5, 1909
Black, Ralph Peters. Div. Engr., Kanawha and Mich. Ry., Charleston, W. Va.		Nov. 8, 1909
Blackmore, George Glover. 36 Jackson Ave., Long Island City, N. Y.		Nov. 30, 1909
Blackwell, Paul Alexander. Asst. Chf. Engr., Virginia Bridge & Iron Co., Roanoke, Va.	Jun. Assoc. M.	Dec. 4, 1900 Jan. 3, 1906
Blair, McCrea Parker. City Engr., City Hall, St. Boniface, Man., Canada.		Feb. 2, 1909

		Date of Membership.
Blamphin, Arthur Merrick Newberry. Asst. City Engr., Room 19, City Hall, New Orleans, La	Jun. Assoc. M.	Dec. 3, 1907 Feb. 2, 1909
Blanchard, Murray. Care, J. G. White & Co., 43 Exchange Pl., New York City		April 2, 1902
Bland, Miles Carlisle. Chf. Engr., Massillon Bridge & Structural Co., 1128 Ohio Bldg., Toledo, Ohio		Sept. 3, 1902
Blatt, Max. Asst. Engr., Dept. of Water Supply, Gas and Electricity (Res., 860 Cauldwell Ave.), New York City		Oct. 5, 1909
Blaylock, John Charles. Business Engr. with H. Eilenberger & Co., 153 La Salle St., Room 1218, Chicago, Ill		Mar. 2, 1909
Bliem, Daniel William. Mgr., Berlin Plant, Am. Bridge Co., East Berlin, Conn		June 5, 1907
Bliss, Edwin Packard. Cons. and Con. Engr. (H. P. Converse & Co.), 88 Broad St., Boston, Mass		July 9, 1906
Bliss, George Henry. Div. Engr., U. S. Reclamation Service, Boise, Idaho		Sept. 7, 1904
Blodgett, John. Contr. Engr., Riverside Bridge Co., Martins Ferry, Ohio	Jun. Assoc. M.	Dec. 4, 1889 Jan. 2, 1901
Blood, Charles Frederick. Civ. Engr. and Contr., 874 Broadway, Room 1001, New York City		Oct. 5, 1909
Blythe, Lucien Hoguet. 158 Bay 34th St., Brooklyn, N. Y	Jun. Assoc. M.	Oct. 31, 1905 April 1, 1908
Boardman, Harold Sherburne. Prof. of Civ. Eng., Univ. of Maine, Orono, Me		Feb. 3, 1904
Boardman, Howard Edward. Asst. Engr., M. of W. Dept., Mo. Pac. Ry., 7th and Poplar Sts., St. Louis, Mo	Jun. Assoc. M.	Oct. 7, 1902 Jan. 4, 1905
Boatrite, James Edwin. Gen. Mgr., The Guerber Eng. Co., Bethlehem, Pa	Jun. Assoc. M.	Feb. 5, 1895 Nov. 3, 1897
Bogen, Louis Edward. Chf. Elec. Estimating Engr., The Allis Chalmers Co. (Res., 171 Twenty-first St.), Milwaukee, Wis	Jun. Assoc. M.	April 30, 1895 June 4, 1902
Boller, Alfred Pancoast, Jr. 45 E. 17th St., New York City	Jun. Assoc. M.	Oct. 2, 1894 May 3, 1899
Boltz, Thomas Franklin. Supt., Huron Products Co.; Address, 5428 Catherine St., Philadelphia, Pa		Oct. 5, 1909
Bond, George Washington, Jr. Township Engr., Weehawken, N. J		Nov. 1, 1905
Bond, Judson Baker. Care, Conrad Land & Water Co., Valier, Mont		June 3, 1908
Bonnett, Charles Pierre. 855 West End Ave., New York City	Jun. Assoc. M.	June 2, 1886 Mar. 6, 1901
Booz, Horace Corey. Prin. Asst. Engr. of Branch Lines, P. R. R., 257 Broad St. Station, Philadelphia, Pa		April 4, 1906

		Date of Membership.
Bos, George Albert. Cons. Engr., Associated with Lewis P. Hobart, Archt., Crocker Bldg., San Francisco, Cal		June 3, 1908
Boucher, William James. 50 Morningside Ave., East, New York City		Sept. 6, 1905
Boughton, Will Hazen. Head of Civ. Eng. Dept., West Virginia Univ.; Cons. Engr. to the Board of Education, Morgantown Dist., Morgantown, W. Va		Nov. 6, 1907
Bourne, Thomas Johnstone. Dist. Engr., Tientsin-Pukow Ry. (Southern Section), Nanking, China		Feb. 7, 1900
Bowditch, John Henry. Asst. Div. Engr., N. Y. Div., B. & O. R. R., New Brighton, N. Y		July 10, 1907
Bowen, Edmund Ignatius. Supt., Delaware and Jefferson Divs., Erie R. R., Susquehanna, Pa		Nov. 1, 1899
Bowen, Sherman Worcester. Structural Engr., 5945 Cote Brilliante Ave., St. Louis, Mo		Sept. 7, 1904
Bowie, Clifford Pinkney. Asst. Engr., Associated Pipe Line Co., 1360 Spring St., Berkeley, Cal		Aug. 31, 1909
Bowler, Frank Colburn. Millinocket, Me		Oct. 5, 1904
Bowne, William Hunt. Glen Cove, N. Y		Dec. 7, 1904
Boyd, Butler Bennett. 3210 F St., San Diego, Cal		Nov. 8, 1909
Boyd, Robert Wright. Cons. Engr., 527 Fifth Ave., New York City		Jan. 8, 1908
Boyer, Charles Carroll. Address unknown		April 4, 1906
Bradshaw, Charles. Care, Bureau of Public Works, Manila, Philippine Islands		Nov. 6, 1907
Bradshaw, Sam Wigfall. Asst. Engr., Estimating Dept., Bridge and Constr. Dept., Pennsylvania Steel Co., Steelton, Pa	Jun. Assoc. M.	Oct. 2, 1900 Feb. 4, 1903
Brady, Joseph. 154 Nassau St., New York City	Jun. Assoc. M.	Sept. 5, 1905 Nov. 4, 1908
Branch, Lester Van Noy. Engr., U. S. Reclamation Service, Pathfinder, Wyo		June 3, 1908
Branch, Thomas Pettus. Prof., Civ. Eng., Georgia School of Technology, Atlanta, Ga		Feb. 5, 1902
Branne, John Severin. Cons. Engr., 1 Madison Ave., New York City (Res., 145 Chester St., Mt. Vernon, N. Y.)		Oct. 5, 1898
Bratton, Edward Elisha. Vice-Pres. and Engr., The Bratton Co., Engrs. and Contrs., Philadelphia, Pa		Oct. 2, 1907
Braune, Gustave Maurice. Asst. Chf. Bridge Designer, Care, Barge Canal, Albany, N. Y	Jun. Assoc. M.	June 2, 1896 Sept. 4, 1901
Breed, Charles Blaney. Asst. Prof. in Civ. Eng., Mass. Inst. Tech.; Cons. Engr. (Barrows & Breed), 6 Beacon St., Boston, Mass		May 6, 1903
Breed, Henry Eltinge. Auditor, Dept., State Engr., State Hall, Albany, N. Y		Mar. 4, 1908

		Date of Membership.
Breneman, Paul Bruce. Assoc. Prof. of Mechanics and Materials of Constr., in Chg. of Dept., The Pennsylvania State Coll., State College, Pa.		Mar. 2, 1909
Brenn, Charles Ferdinand. Chf. Engr. of Mines, C., M. & St. P. Ry., 194 Fullerton Ave., Chicago, Ill.		May 4, 1904
Brereton, Thomas John. Engr., Cumberland Val. R. R., Chambersburg, Pa.	Jun. Assoc. M.	Oct. 7, 1885 June 5, 1895
Brewer, Jesse Irving. Asst. Engr., Interborough Rap. Trans. Co., 32 Park Pl., New York City		Oct. 5, 1909
Briggs, Harry Alson. Engr. with MacArthur Bros. Co., Brown Station, N. Y.		May 1, 1907
Bright, Charles Edwin. U. S. Supt., Colbert Shoals Canal, Riverton, Ala.		Dec. 3, 1902
Brillhart, Jacob Herbst. Chf. Engr., The Guerber Eng. Co. (Res., 342 N. Seventh Ave.), Bethlehem, Pa.	Jun. Assoc. M.	Nov. 1, 1904 Nov. 4, 1908
Brink, Lawrence Calvin. New Paltz, Ulster Co., N. Y.		Oct. 7, 1908
Brinkley, Milo Hamilton. Asst. Engr., G. N. Ry., 6512 Sixteenth Ave., N. W., Seattle, Wash.	Jun. Assoc. M.	Mar. 1, 1904 Jan. 8, 1908
Brinsmade, Daniel Edwards. Secy., The Ousatonic Water Power Co., Box 95, Derby, Conn.		April 6, 1904
Brodie, Orrin Lawrence. Asst. Engr., Board of Water Supply, 299 Broadway, New York City		July 10, 1907
Brogan, Thomas Byrnes. Eng. Insp., Board of Water Supply, Headquarters Dept., Distribution Div.; Address, 596 Riverside Drive, New York City		Feb. 1, 1910
Brook-Fox, Evelyn. Townsend House, Halberton, Tiverton, Devonshire, England		Feb. 2, 1898
Brooke, George Doswell. Div. Engr., B. & O. R. R., Camden Station, Baltimore, Md.		Nov. 7, 1906
Brooks, John Pascal. Associate Prof. of Civ. Eng., Univ. of Illinois, 1005 California Ave., Urbana, Ill.		April 1, 1896
Brooks, Miles Elijah. Asst. Engr., Const. Dept., Canadian Pacific Ry., Windsor Station, Montreal, Que., Canada.		July 9, 1906
Brower, Edward Sylvester. Cons. Engr., 95 Liberty St., New York City		Dec. 2, 1903
Brower, Irving Clinton. Asst. Engr., C. & N. W. Ry., Care, E. C. Carter, Chf. Engr., Chicago, Ill.		Nov. 30, 1909
Brown, Alfred Thomas. Dept. of Highways, Borough of the Bronx, Cor. 177th St. and 3d Ave., New York City	Jun. Assoc. M.	Nov. 1, 1904 Jan. 5, 1909
Brown, Burtis Scott. Structural Engr., 161 Devonshire St., Room 709, Boston, Mass.		Oct. 5, 1909
Brown, Charles Eugene. 33 Oakwood Ave., Hudson Heights, N. J.		Mar. 4, 1908

		Date of Membership.
Brown, Charles Franklin. 317 Boston Bldg., Salt Lake City, Utah		Oct. 7, 1908
Brown, Clark. Barge Canal Office, Albany, N. Y		April 1, 1908
Brown, Collingwood Bruce, Jr. Div. Engr., Canadian Pacific Ry., Montreal, Que., Canada	Jun. Assoc. M.	Oct. 1, 1901 April 6, 1909
Brown, Marshall Wright. With Carter Constr. Co., Chicago, Ill.; Address, 137 S. Broadway, Nyack, N. Y		Nov. 4, 1908
Brown, Robert King. Engr., M. of W., S. P., L. A. & S. L. R. R. Co., Room 228, Union Station, Salt Lake City, Utah		June 7, 1893
Brown, Rodman Merritt. Pres., Brown & Read Co., Engrs. and Contrs., 1212 Hartford Bldg., Chicago, Ill		Feb. 1, 1905
Brown, Samuel Coughlin. 15 West 83d St., New York City.		Nov. 1, 1905
Brown, Stephen Pearson. Engr. for T. B. Bryson, 165 Broadway, New York City		Oct. 5, 1904
Brownell, Leonard Dempster. 432 Cortland Ave., Syracuse, N. Y		Nov. 6, 1907
Bruning, Henry Diedrich. Civ. and Cons. Engr., 404 White Bldg., Seattle, Wash		Oct. 7, 1908
Brush, Carl Fletcher. Eyota, Minn		Mar. 4, 1908
Brush, William Whitlock. Deputy Chf. Engr., Dept. of Water Supply, Gas and Electricity, 13 Park Row, New York City	Jun. Assoc. M.	Mar. 3, 1896 April 5, 1905
Bryson, Thomas Bines. Contr. Engr., 165 Broadway, New York City		Feb. 7, 1900
Buck, Con Morrison. City Engr., 615 Poyntz Ave., Manhattan, Kans		Dec. 6, 1905
Bugbee, Newton Albert Kendall. 207 Academy St., Trenton, N. J		Oct. 5, 1904
Bumsted, Eugene Bradford. Const. Engr., Stone & Webster Eng. Corporation, Reno, Nev	Jun. Assoc. M.	May 1, 1900 Mar. 6, 1907
Bunnel, William Cyrus. U. S. Asst. Engr., U. S. Engr. Office, Box 155, Manila, Philippine Islands	Jun. Assoc. M.	Oct. 1, 1901 Jan. 2, 1907
Burchard, Anson Wood. 21 Front St., Schenectady, N. Y		May 3, 1893
Burden, Morton. Care, Eng. Dept., Am. Bridge Co., Frick Bldg., Pittsburg, Pa	Jun. Assoc. M.	Feb. 4, 1896 Jan. 2, 1901
Burdick, Charles Baker. Hydr. and San. Engr., 1212 Hartford Bldg., Chicago, Ill		Mar. 1, 1905
Burgess, Philip. Cons. San. and Chem. Engr. (Burgess, Kimberly & Long), Columbus, Ohio		Nov. 7, 1906
Burgoyne, John Henry, Jr. Engr., Amazon & Pacific Ry., La Oroya, Peru	Jun. Assoc. M.	Sept. 1, 1903 Dec. 5, 1906
Burns, Joseph Patrick. 339 Franklin St., Watertown, N. Y		Dec. 1, 1908
Burns, Louis Andrew. Asst. Engr., New York State Barge Canal Office, Rome, N. Y		July 1, 1909

		Date of Membership
Burrage, John Otis. Cons. Engr., 3400 Washington St., San Francisco, Cal.	Jun. Assoc. M.	Mar. 1, 1904 Nov. 4, 1908
Burrell, Glenn Smith. Asst. Civ. Engr., U. S. N., Naval Station, Honolulu, Hawaii		Aug. 31, 1909
Burton, William. Asst. Tunnel Engr., Detroit River Tunnel Co. (Res., 108 Charlotte Ave.), Detroit, Mich.	Jun. Assoc. M.	Oct. 3, 1908 May 4, 1909
Burwell, Robert Lemmon. Asst. Engr., Baltimore Sewerage Comm., Storm Water Div., 134 West Lanvale St., Baltimore, Md.	Jun. Assoc. M.	Dec. 3, 190 July 1, 1908
Bush, Philip Lee. Supt., Supply and Constr. Dept., Cal. Fruit Canners Assoc., 120 Market St., San Francisco, Cal.		Sept. 5, 1906
Butcher, William Laramy. Cambridge, Mass.		May 4, 1904
Butchers, Earle Burdette. Draftsman for Am. Bridge Co., Ambridge, Pa.		Jan. 8, 1908
Butler, Alfred Dickey. Asst. City Engr., Spokane, Wash.		Oct. 5, 1909
Butler, John Soule. U. S. Junior Engr., Lock No. 21, Eadsville, Ky.		Mar. 4, 1908
Butterfield, Herbert Mitchell. Care, J. Aird & Co., Tanjong Pogar Dock Works, Singapore, Straits Settlements		Oct. 3, 1906
Butz, George Wishart. Schuylkill Haven, Pa.		April 6, 190
Buzzell, Josiah William. 507 Park Ave., East Orange, N. J.		April 6, 1904
Cameron, Harry Frank. Bureau of Public Works, Manila, Philippine Islands		Oct. 2, 190
Cameron, John Bobbs. 401 Edgar St., Evansville, Ind.	Jun. Assoc. M.	Oct. 2, 1906 Feb. 3, 190
Campbell, Duncan Hugh. Div. Engr., Montana R. R., Box 57, Butte, Mont.		July 1, 1909
Campbell, Henry Avery. Engr. in Chg. of Bureau of Inspection of the Merchants Assoc., 1039 Merchants Exchange Bldg., San Francisco, Cal.	Jun. Assoc. M.	April 4, 1907 April 6, 1909
Carberry, Ray Sheppard. Engr., Irrig. Mgr., U. S. Reclamation Service, Mitchell, Nebr.		Mar. 4, 1908
Carey, Edward Gilman. Asst. Engr. with E. De V. Tompkins, 81 East 125th St., New York City		July 1, 1909
Carlin, Joseph Patrick. Secy. and Treas., P. J. Carlin Constr. Co., 16 East 23d St., New York City	Jun. Assoc. M.	Oct. 4, 1898 Sept. 6, 1905
Carpenter, Clarence Edson. Road Engr., Interborough Rapid Transit Co., 33 Bruce Ave., Yonkers, N. Y.		July 10, 1907
Carrick, Robert Edward. Engr., The Gen. Fireproofing Co., 257 East 133d St., New York City	Jun. Assoc. M.	April 30, 1907 April 6, 1909

		Date of Membership.
ARROLL, CHARLES JOSEPH. Care, Hotel Richelieu, Durango, Mexico		Oct. 5, 1904
ARSTARPHEN, FREDERICK CHARLES. Cons. Min. and Civ. Engr.; Pres., The F. C. Carstarphen Contr. Co., 517 Ideal Bldg., Denver, Colo		April 6, 1909
ARTER, ALFRED ELLSWORTH. Res. Engr., Rapid Transit Subway Constr. Co. (Res., 706 West 180th St.), New York City		June 4, 1902
ARTER, FRANK HARVIE. Designing Engr., Bost. Elev. Ry. Co., Cambridge Main St. Subway, 147 Magazine St., Cambridge, Mass		Jan. 4, 1905
ARTER, RICHARD WILLIAM. Bridge Engr., Key West Extension, Florida East Coast Ry., Marathon, Fla		Oct. 1, 1902
ARVER, GEORGE PAYSON. 53 State St., Boston, Mass		Oct. 2, 1907
AUTHORN, EDWARD BEAUFORD. City Engr., Columbia, Mo		June 5, 1907
CHACE, IRA MASON, JR. Engr., J. W. Bishop Co., Gen. Contrs. (Res., 70 Borden St.), New Bedford, Mass		Oct. 2, 1907
HADBOURNE, EDWARD MERRIAM. Pres. and Gen. Mgr., E. M. Chadbourne Co., Engrs. and Contrs., 800 Postal Telegraph Bldg., San Francisco, Cal	Jun. Assoc. M.	Nov. 3, 1903 Oct. 2, 1907
CHAMBERLAINE, ROBERT LLOYD. Asst. Engr. and Chf. Draftsman, United Railways & Elec. Co. (Res., 2733 Maryland Ave.), Baltimore, Md		Oct. 2, 1907
CHAMBERS, HENRY WICK. Asst. Engr., Office of Vice-Pres. and Gen. Mgr., N. Y. C. & H. R. R. R., 305 Grand Central Station, New York City		Feb. 5, 1908
CHAMBERS, HERBERT JAMES. (Hamilton & Chambers, Steel Engrs. and Contrs.), 29 Broadway, New York City		Nov. 5, 1902
CHANDLER, ELWYN FRANCIS. Prof. of Mathematics, State Univ. of North Dakota, University, N. Dak		Feb. 1, 1910
CHAPMAN, HARRY DAY. Box 272, Ocean Park, Cal		Oct. 7, 1908
CHAPMAN, PAUL. 1546 Minford Pl., Bronx, New York City		June 6, 1906
CHARLES, LAVERN JOHN. Care, U. S. Reclamation Service, Ellensburg, Wash		Oct. 7, 1908
CHARLSWORTH, WILLIAM SAXON. Authorized Surv., Levin, New Zealand		Nov. 1, 1899
CHARNLEY, WALTER. Prin. Asst. Engr., Mexico North Western Ry. Co., Nueva Casas Grandes, Chihuahua, Mexico		May 4, 1909
CHASE, RICHARD DAVENPORT. 59 Fourth St., New Bedford, Mass	Jun. Assoc. M.	Oct. 5, 1897 Oct. 3, 1900
CHASE, RUSSELL. Prin. Asst. Engr., O. R. & N. Co., New Wells Fargo Bldg., Portland, Ore		Feb. 1, 1905
CHASE, WILLIAM HENRY. 162 Allen St., New Bedford, Mass		April 3, 1907
CHESTER, CHARLIE ELLSWORTH. Civ. Engr. and Mgr. of Water Co., Shelbyville, Ill		May 4, 1898

		Date of Membership.
CHEW, RICHARD SANDERS. 607 Humboldt Bank Bldg., San Francisco, Cal		Sept. 5, 1906
CHIPMAN, PAUL. Room 4, Dickman Bldg., Evansville, Ind		Oct. 2, 1907
CHURCHILL, PERCIVAL MITCHELL. With U. S. Engrs., Elmwood, Mass		June 1, 1904
CILLEY, MORGAN. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands		Nov. 8, 1909
CLAPP, FRANK LEMUEL. Asst. Engr., Board of Water Supply of City of New York, Cornwall-on-Hudson, N. Y		May 4, 1909
CLAPP, GEORGE HUBBARD. Pres., Pittsburgh Testing Laboratory, 325 Water St., Pittsburg, Pa		July 1, 1891
CLAPP, SIDNEY KINGMAN. Asst. Engr., Board of Water Supply, West Shokan, N. Y		April 5, 1905
CLAPP, WILFRED ATHERTON. Civ. Engr. and Supt. of Constr., Quartermaster's Dept., U. S. A., 103 Sherman St., Portland, Me		April 4, 1906
CLARK, EDWIN. Structural Engr. and Chf. of the Bureau of Bldg. Inspection, Room 313, City Hall, Philadelphia, Pa		Jan. 6, 1897
CLARK, WARREN VESTER. 500 First National Bank Bldg., Berkeley, Cal		Mar. 7, 1906
CLARKE, ELWYN LORENZO. Civ. and Hydr. Engr., 126 North Main St., Sheridan, Wyo		April 1, 1908
CLARKE, WILLIAM DEXTER. (Hegardt & Clarke), Board of Trade Bldg., Portland, Ore		July 10, 1907
CLASS, CHARLES FRANK. Asst. Engr., Am. Coke & Gas Constr. Co. (Res., 1468 Kenwood Ave.), Camden, N. J	Jun. Assoc. M.	Mar. 3, 1903 April 4, 1906
CLAUSEN, JACOB CENTENNIAL. Engr. in Chg. of Sewer Constr., 2063 West 28th St., Los Angeles, Cal		Sept. 6, 1905
CLAYBAUGH, HARRY WRAY. Div. Engr., Pa. State Highway Dept., Franklin, Pa		June 1, 1909
CLEAVER, PITSON JAY. Montezuma, N. Y	Jun. Assoc. M.	April 4, 1899 May 1, 1907
CLINTON, SAMUEL DEXTER. Chf. Engr., Portneuf-Marsh Val. Irrig. Co., Downey, Idaho		Oct. 5, 1909
COATES, FRANK RAYMOND. Vice-Pres., Inter Ocean Steel Co., 217 Railway Exchange, Chicago, Ill		Jan. 3, 1900
COBB, STEPHEN PRENTIS. Assoc. Engr., Rochester Ry. & Light Co., 34 Clinton Ave., N., Rochester, N. Y		Mar. 4, 1908
COCHRANE, VICTOR HUGO. Asst. Engr., Waddell & Harrington, Orear-Leslie Bldg., Kansas City, Mo		Oct. 4, 1905
COHEN, CHARLES. Civ. and Cons. Engr.; City Surv., 167th St. and Findlay Ave., New York City		Mar. 6, 1907
COKEFAIR, FRANCIS ALBERTSON. Chf. Engr., Great Northern Power Co., Duluth, Minn		April 6, 1904

		Date of Membership.
Cole, Burt. Engr., Mt. Olive & Staunton Coal Co., Staunton, Ill		Jan. 2, 1901
Cole, Clinton Llewellyn. With The H. Wales Lines Co. (Res., 94 Linsley Ave.), Meriden, Conn		May 6, 1908
Cole, Edward Smith. Hydr. Engr., 220 Broadway, New York City		Sept. 7, 1904
Cole, Harry Outen. Asst. Engr., Pacific Div., Corozal, Canal Zone, Panama		Jan. 4, 1905
Cole, Herbert Nichols. Constr. Engr., Semet Solvay Co., Syracuse, N. Y		Jan. 6, 1904
Cole, Osman Fred. 7333 Harvard Ave., Chicago, Ill		Sept. 2, 1908
Coleman, Henry Fitch. 404 Seventh St., Logansport, Ind		Mar. 6, 1895
Collins, Charles Edwin. Cons. Engr., 321 Drexel Bldg., Philadelphia, Pa		Mar. 2, 1904
Collins, Clarke Peleg. Civ. and Min. Engr., 809 Johnstown Trust Bldg., Johnstown, Pa		June 4, 1902
Collins, Frank David. Engr., Koken Iron Works, St. Louis, Mo		Oct. 7, 1908
Collins, Frank Joseph. Supt., Stewart Kerbaugh Shanley Co., 600 E. Fayette St., Syracuse, N. Y		Nov. 8, 1909
Collins, George James Schilling. 414 Bee Bldg., Omaha, Nebr		June 5, 1907
Collins, John T. Res. Engr., Hudson Div., N. Y. C. & H. R. R. R. Co., Poughkeepsie, N. Y		May 1, 1907
Colnon, Redmond Stephen. Gen. Contr. (Fruin & Colnon), 615 Laclede Bldg., St. Louis, Mo		July 9, 1906
Colvin, Donald Dean. Chf. Engr., Pan-American R. R., Gamboa, Oaxaca, Mexico		May 6, 1908
Congdon, John Potter. Superv. Engr., Ore. Short Line R. R., Pocatello, Idaho		May 3, 1905
Conger, Alger Adams. Asst. Hydr. Engr., J. G. White & Co., 43 Exchange Pl., New York City		Oct. 1, 1902
Conkling, Leon De Vere. Asst. Prof. of Civ. Eng., Lehigh Univ., South Bethlehem, Pa		Dec. 4, 1901
Conley, Clyde Greyson. Asst. Engr., The Mt. Vernon Bridge Co., Mt. Vernon, Ohio		Aug. 31, 1909
Connell, Henry Leo. Asst. Engr., Board of Water Supply of New York City, Brown Station, Ulster Co., N. Y		Jan. 4, 1910
Conner, Ralph Melvin. Engr., U. S. Reclamation Service, Helena, Mont	Jun. Assoc. M.	May 1, 1906 Aug. 31, 1909
Connick, Harris De Haven. Chf. Asst. Engr., Dept. of Public Works, Care, City Engr., San Francisco, Cal	Jun. Assoc. M.	Jan. 3, 1899 Feb. 4, 1903
Connor, William Durward. Capt., Corps of Engrs., U. S. A., Commanding Co. "B," 1st Battalion of Engrs., Washington Barracks, Washington, D. C		Jan. 7, 1903

		Date of Membership.
CONRAD, LOWELL EDWIN. Prof. of Civ. Eng., Kansas State Agri. Coll., Manhattan, Kans.		Oct. 3, 1906
CONVERSE, WILLIAM HASSON. Pres., Converse Bridge Co., Chattanooga, Tenn.		Jan. 6, 1892
CONWAY, JOHN SEBASTIAN. Engr., U. S. Reclamation Service, North Yakima, Wash.		May 4, 1909
CONZELMAN, JOHN EDWARD. Chf. Engr., Unit Constr. Co., Holland Bldg., St. Louis, Mo.		April 4, 1906
COOKE, FREDERICK HOSMER. Civ. Engr., U. S. N., Bureau of Yards and Docks, Navy Dept., Washington, D. C.		July 9, 1906
COOKE, GEORGE RICHARDSON. 1109 Ford Bldg., Detroit, Mich.		June 3, 1908
COOKE, SAINT GEORGE HENRY. Chf. Engr., West Chester & Wilmington Ry., Real Estate Trust Bldg., Philadelphia (Res., 608 Morton Ave., Ridley Park), Pa.		Jan. 5, 1909
COOMER, ROSS MILLER. Asst. Engr. on Grade Crossing Elimination Impvt., N. Y. C. & H. R. R. R. (Res., 2541 Main St.), Buffalo, N. Y.		Nov. 4, 1908
COOPER, DAVID REGINALD. Office Engr., State Water Supply Comm., Lyon Blk., Albany, N. Y.		July 1, 1908
COOPER, KENNETH FARRA. Mgr., Am. Cyanamid Co., Niagara Falls, Ont., Canada	Jun. Assoc. M.	Oct. 6, 1903 Jan. 8, 1908
COPLAND, ALEXANDER CHISHOLM. Designing Engr., C. & O. Ry., Room 30, General Offices, Richmond, Va.		Mar. 2, 1909
COPLEY, GEORGE NOBLE. Treas., Goedhart & Bates; Secy. and Treas., U. S. Eng. Co., 324 Security Bldg., Galveston, Tex.	Jun. Assoc. M.	April 3, 1906 Oct. 5, 1909
CORBY, CHARLES EDWARD. In Chg. of Drafting Room, N. Y. City Ry., 552 McDonough St., Brooklyn, N. Y.		Oct. 4, 1893
COREY, RAY HOWARD. Nisqually Power Plant, 303 City Hall, Tacoma, Wash.		Oct. 3, 1906
CORLETT, BERTRAM EDWIN. 602 D. S. Johnston Bldg., Seattle, Wash.		May 4, 1909
CORNELL, DOUGLAS. Structural Engr. and Acting Commr., Bureau of Bldgs., Dept. of Public Works, Buffalo, N. Y.		Sept. 6, 1899
CORNING, DUDLEY TIBBITS. M. E. and S. Dept., Cambria Steel Co., Johnstown, Pa.		Oct. 1, 1902
CORNISH, LORENZO DANA. Designing Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Jun. Assoc. M.	April 5, 1904 Feb. 7, 1906
CORRIGAN, GEORGE WASHINGTON. Asst. Engr., S. P. Co., San Luis Obispo, Cal.	Jun. Assoc. M.	Feb. 5, 1901 Oct. 5, 1904
CORTI, JOSEPH JAMES. Casilla Correa 68, Mendoza, Argentine Republic		Jan. 1, 1896
COTHER, ALBERT ADIEL. 908 C. & N. W. Gen. Office Bldg., Chicago, Ill.		April 1, 1908
COTHRAN, THOMAS WHITE. Greenwood, S. C.		July 9, 1906

		Date of Membership.
COULSON, BENJAMIN LEFEVRE. Prof of Eng., Univ. of the South, Sewanee, Tenn.		May 6, 1908
COULTER, WALDO SCARLETTE. Asst. Engr., New York State Barge Canal, Dept. State Engr. and Surv., Lyon Bldg., Albany, N. Y.		May 6, 1908
COVELL, VERNON ROYCE. Deputy County Engr., Court House, Pittsburg, Pa.		Mar. 7, 1906
COVERDALE, WILLIAM HUGH. Cons. Engr., 66 Broadway, New York City	Jun. Assoc. M.	Jan. 2, 1894 Oct. 3, 1900
COVERT, CLERMONT C. Dist. Engr., U. S. Geological Survey, Room 18, Federal Bldg., Albany, N. Y.		July 1, 1909
COWLES, LUZERNE SIMEON. Asst. Designing Engr., Elevated and Subway Constr., Bost. Elev. Ry. Co., 101 Milk St., Boston, Mass.		May 1, 1907
COWLES, WILLIAM PIERCE. Cons. Engr., New York Life Bldg., Minneapolis, Minn.		Nov. 7, 1906
COWPER, JOHN WHITFIELD. Vice-Pres., Worden-Allen Co., 115 Adams St., Chicago, Ill.	Jun. Assoc. M.	June 21, 1894 Oct. 2, 1901
CRAIG, GEORGE WASHINGTON. City Engr., Omaha, Nebr.		Feb. 7, 1906
CRAIG, PHILIP INSLEY. Flemington, N. J.		Feb. 3, 1904
CRAIG, WASHINGTON RIGHTER. Chf. Engr., Shawmut Min. Co., St. Marys, Pa.	Jun. Assoc. M.	May 1, 1894 Oct. 1, 1902
CRAIN, ARTHUR MANCHESTER. Engr. and Contr., Brandeis Bldg., Omaha, Nebr.	Jun. Assoc. M.	Jan. 3, 1907 Dec. 1, 1908
CRANE, JOSEPH SPENCER. Engr. and Contr. (Walter E. Isetts & Co.), (Res., 668 Clifton Ave.), Newark, N. J.	Jun Assoc. M.	Dec. 5, 1905 Nov. 4, 1908
CREELMAN, CHARLES LAUDER. 431 Provident Bldg., Tacoma, Wash.		Mar. 4, 1908
CRISP, ERNEST JOHN. 406 West Ave., Elyria, Ohio.	Jun. Assoc. M.	Oct. 31, 1905 April 1, 1908
CROOK, JOHN ANTHONY. Proprietor, Monarch Eng. Co.; Pres., Monarch Constr. Co., Falls City, Nebr.	Jun. Assoc. M.	Feb. 3, 1903 Dec. 1, 1908
CROSBY, HEWITT. With Post & McCord, 44 East 23d st., New York City		Oct. 5, 1909
CROSETT, JAMES HAVEN. Engr. and Supt., Visalia Elec. R. R. Co., P. O. Box 117, Exeter, Cal.		Jan. 4, 1905
CRYDER, HOWARD MICHAEL. Fullerton Bldg., St. Louis, Mo.		June 6, 1906
CRYSLER, ARTHUR GARFIELD. Asst. Engr. on Barge Canal Work, 126 Shonnard St., Syracuse, N. Y.		Aug. 31, 1909
CUDDEBACK, ALLAN WINTER. Engr. and Supt., Passaic Water Co., Paterson, N. J.		April 5, 1899
CUDWORTH, FRANK GRANT. Cons. Engr. and Archt., 601 Kansas City Life Bldg., Kansas City, Mo.		Jan. 3, 1900

		Date of Membership.
Culgin, Guy Whitmore. Asst. Engr., Rapid Transit Subway Constr. Co., 165 Broadway (Res., 144 West 78th St.), New York City	Jun. Assoc. M.	Mar. 6, 1900 Sept. 7, 1904
Cummings, Elmore David. U. S. Asst. Engr., 3110 W. North Ave., Baltimore, Md		Nov. 4, 1903
Cummings, Noah. Asst. Engr., Dept. of Bridges, 221 West 141st St., New York City	Jun. Assoc. M.	Mar. 3, 1896 Jan. 6, 1904
Cunningham, Edward Walter. The Eastman, Detroit St., Cleveland, Ohio		Oct 2, 1907
Cunningham, John George Lawrence. Bldg. Inspector, St. Paul, Minn		Jan. 5, 1909
Cunningham, Stanley, Jr. Engr. for Edward Burnett & Alfred Hopkins. 11 East 24th St., New York City		Oct. 3, 1906
Curtis, Clinton Alonzo. Asst. Engr., N. Y. State Barge Canal, Fort Edward, N. Y	Jun. Assoc. M.	Oct. 1, 1907 Oct. 5, 1909
Curtis, Loren Bradley. 548 Equitable Bldg., Denver, Colo		July 10, 1907
Curtis, Varnum Pierce. Cons. Engr. and Contr., 96 Stafford St., Worcester, Mass		Dec. 7, 1904
Daggett, Fred Wallis. Concrete Engr., 1010 Paddock Bldg., Boston, Mass		May 1, 1907
Dalrymple, Francis Wharton. City Engr., Bayonne, N. J		Feb. 7, 1894
Daniels, Mark Roy. Civ. and Hydr. Engr., 517 Monadnock Bldg., San Francisco, Cal		Nov. 4, 1908
Daniels, Thomas Remington Holden. Cons. Engr., Terre Haute, Indianapolis & Eastern Traction Co., 911 Terminal Bldg., Indianapolis, Ind		Feb. 6, 1907
Darling, John Whitson. Chf. Engr., Buffalo, Thousand Islands & Portland R. R., 102 Gluck Bldg., Niagara Falls, N. Y		June 7, 1905
Darrow, Marius Schoonmaker. Chf. Engr., Irrigated Lands Co., 508 Newhouse Blk., Salt Lake City, Utah	Jun. Assoc. M.	Feb. 6, 1900 Dec. 1, 1908
Darrow, Wilton Joseph. Cons. Engr. (Balcom & Darrow), 314 Madison Ave., New York City		Nov. 1, 1905
Darwin, Walton Pruett. Care, Superv. Archt., U. S. Treasury Dept., Washington, D. C		Feb. 6, 1907
Dater, Philip Herrick. Res. Engr., Barge Canal, Little Falls, N. Y		April 5, 1905
Daugherty, Henry Michael. Constr. Supt., J. G. White & Co., Crane Val. Dam, North Fork, Madera Co., Cal		May 6, 1908
Davenport, James Watson. Res. Engr., Lake View Traction Co., North Memphis Saving Bank Bldg., Memphis, Tenn.		Nov. 30, 1909
Davies, William Gomer. Willows, Cal	Jun. Assoc. M.	Feb. 2, 1904 Nov. 8, 1909

		Date of Membership.
Davis, Benjamin Herman. Asst. Engr., D., L. & W. R. R. Co., Hoboken, N. J.		Nov. 30, 1909
Davis, Fred Carnot. Civ. and Hydr. Engr. (Pratt & Davis), 117 Main St., Fitchburg, Mass.		Oct. 7, 1908
Davis, Fred Rufus. Insp., Assoc. Factory Mutual Fire Ins. Cos., 1515 Arch St., Philadelphia, Pa.		Nov. 5, 1902
Davis, Frederick. Asst. Supt., Santa Cruz Portland Cement Co., Davenport, Cal.		Oct. 4, 1905
Davis, George Jacob, Jr. Asst. Prof. of Hydr. Eng., Univ. of Wisconsin, 1731 Regent St., Madison, Wis.	Jun. Assoc. M.	Nov. 4, 1902 Oct. 2, 1907
Davis, George Robert. Topographer, U. S. Geological Survey, Sacramento, Cal.		April 3, 1907
Davis, Gilbert Louis. Supt. of Irrig., U. S. Reclamation Service, Ridgelawn, Mont.		Mar. 4, 1908
Davis, Harold. 31st & K Sts., Washington, D. C.		Oct. 2, 1901
Davis, James Lyford. Asst. Engr., Board of Water Supply, City of New York, 147 Varick St., New York City		May 4, 1904
Davis, John Charles. Dean of Coll. of Applied Science and Eng., Marquette Univ., Milwaukee, Wis.		July 1, 1909
Davis, William Russell. Chf. Bridge Designer and Insp., Office of State Engr. of New York, 6th Floor, De Graaf Bldg., Albany, N. Y.		May 2, 1900
Davoud, Vahram Yettvart. Elec. Engr., The Telluride Power Co., Provo, Utah		July 1, 1909
Day, Edward Bliss. Pres., Federal Lumber Co., Blaine, Wash.		Feb. 4, 1903
Deacon, Ernest Franklin. Chf. Engr., Virginia Southern R. R., Abingdon, Va.		July 10, 1907
Dean, Stanley. Instr. in Dept. of Civ. Engr., Armour Inst. of Tech., 7217 Perry Ave., Chicago, Ill.		April 1, 1908
DeBerard, Wilford Willis. Asst. Engr., Met. Sewerage Comm., 17 Battery Pl., New York City		May 2, 1906
Decker, John Hull. Chf. Engr. and Gen. Mgr., Atlantic Constr. & Supply Co., 232 Bartlett Bldg., Atlantic City, N. J.	Jun. Assoc. M.	Sept. 6, 1904 Dec. 5, 1906
DeGraff, Harry Westbrook. Deputy State Engr., State Hall, Albany, N. Y.		Jan. 3, 1906
de Gratresse, Joseph Reygondeau. 612 West 115th St., New York City		Jan. 2, 1907
De La Mater, Stephen Truesdell. Estimator, 807 Security Bldg., Chicago, Ill.		Nov. 4, 1908
DeMott, Charles Leonard. 47 Law Bldg., Lynchburg, Va.		June 6, 1906
Dempster, Osborne Joel. City Engr., Little Falls, N. Y.		Jan. 3, 1906
Dennis, Harry Whiting. Care, Southern Cal. Edison Co., Los Angeles, Cal.		Oct. 2, 1907

		Date of Membership.	
DENT, ELLIOTT JOHNSTONE. Capt., Corps of Engrs., U. S. A., Vancouver Barracks, Vancouver, Wash.		May	1, 1907
DENT, WALTER DEVERE. Care, J. E. Sirrine, Greenville, S. C.		Nov.	8, 1909
DERBY, CHESTER CAWTHORNE. Chf. Draftsman, Dept. of Yards and Docks, Navy Yard, New York; Address, 50 Elm St., Richmond Hill, N. Y.		May	4, 1909
DERR, HOMER MUNRO. Prof. of Civ. Eng., South Dakota State Coll., and Asst. Engr., South Dakota R. R. Comm., Brookings, S. Dak.		Jan.	4, 1910
DEVLIN, HENRY STRATFORD. Office, Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City (Res., 349 Clinton St., Brooklyn, N. Y.)		June	5, 1907
DE VOU, JAMES LAIRD. Asst. Engr., Erecting Dept., Am. Bridge Co. of N. Y., Room 1530 Frick Bldg., Pittsburg, Pa.		April	1, 1903
DIAMANT, ARTHUR HERBERT. Cons. Engr., Silverman Constr. Co., 103 Park Ave. (Res., 531 West 124th St.), New York City	Jun. Assoc. M.	May Dec.	5, 1903 5, 1906
DICKE, EDWARD CHRISTIAN. 4670 Gibbons St., St. Louis, Mo.	Jun. Assoc. M.	May April	3, 1904 6, 1909
DIECK, ROBERT GEORGE. 614 Corbett Bldg., Portland, Ore.		Nov.	6, 1907
DIEDEN, GOTTHARD VINCENT. Cons. Engr., 47 Stortorget, Malmo, Sweden		Oct.	2, 1907
DIEHL, DAVID LESLIE. Engr. and Contr. (Whittaker & Diehl and Ferro Concrete Co.), Union Trust Bldg., Harrisburg, Pa.		Jan.	5, 1909
DILKS, LORENZO CARLISLE. Contr. Mgr., The Eastern Steel Co., 71 Broadway, New York City		Jan.	3, 1906
DILLARD, JOHN LEA. Gen. Mgr., The Sturm & Dillard Co., Converse, Ind.		June	1, 1904
DILLON, FRANCIS HENRY. Civ. Engr. and Contr. (Mackin & Dillon), Apartado 221, Monterey, Nuevo Leon, Mexico		Oct.	3, 1900
DINGLE, JAMES HERVEY. City Engr., Charleston, S. C.	Jun. Assoc. M.	April Oct.	30, 1895 4, 1899
DIXON, DE FOREST HALSTED. Gen. Supt., Turner Constr. Co., 11 Broadway, New York City (Res., 27 Grace Court, Brooklyn, N. Y.)	Jun. Assoc. M.	May Feb.	3, 1898 3, 1904
DODD, ALBERT BEESTON. Engr., U. S. Reclamation Service, Mare Island Navy Yard, Vallejo, Cal.		Sept.	5, 1906
DODD, JOHN HUGH. Jamaica Govt. Ry., Kingston, Jamaica		Mar.	6, 1907
DODGE, SAMUEL DOUGLASS. Asst. Engr., Board of Water Supply of City of New York, Cornwall-on-Hudson, N. Y.		Nov.	6, 1907
DOEBLER, VALENTINE SHERMAN. Supt. Transportation, Cam. Steel Co., Johnstown, Pa.		Dec.	6, 1893
DONAHEY, JOSEPH ALEXANDER. Res. Engr., L. S. & M. S. Ry., R. F. D. No. 6, Kent, Ohio		Dec.	4, 1907

		Date of Membership.
Donald, Robert L'Amy. Cons. Engr., Failing Bldg., Portland, Ore.		May 1, 1907
Dorrance, William Tully. Dist. Engr., N. Y. C. & H. R. R. R., Union Station, Albany, N. Y.		Sept. 4, 1901
Dorsey, Leander. Asst. Engr., Baltimore Sewerage Comm., 908 American Bldg., Baltimore, Md.		Oct. 4, 1905
Dorsey, William Henry. Engr. and Mgr., Sanford & Brooks Co., 24 Commerce St., Baltimore, Md.		June 5, 1907
Doten, Leonard Smith. Civ. Engr., War Dept. (Res., 410 A St., N. E.), Washington, D. C.		July 9, 1906
Doty, John Williams. With The Foundation Co., 115 Broadway, New York City	Jun. Assoc. M.	Nov. 3, 1903 Jan. 4, 1905
Dougan, James. Engr. with Clinton & Russell, 32 Liberty St., New York City	Jun. Assoc. M.	Mar. 5, 1901 Mar. 2, 1904
Downer, Thomas Benson. Chf. Engr., San Diego Constr. Co., 1117 D St., San Diego, Cal.		Oct. 2, 1907
Downes, Alfred Kimball. Box 509, Monroe, La.		Feb. 3, 1904
Downman, Julian Romney. The Plains, Va.		Dec. 4, 1901
Doyle, Henry Sisson. Gen. Mgr., Reinforced Concrete Dept., Am. Steel & Wire Co., Chicago, Ill.		Jan. 8, 1908
Doyle, John Stephen. 2451 Maryland Ave., Baltimore, Md.		Nov. 7, 1906
Drake, Robert Morris. Dist. Engr., S. P. Co., Room 1052, Flood Bldg., San Francisco, Cal.		Mar. 7, 1900
Drane, Brent Skinner. Asst. Engr., Porto Rico Irrig. Service, Guayama, Porto Rico		July 10, 1907
Drew, Charles Davis. With J. G. White & Co., Ltd., 9 Cloak Lane, London, E. C., England		Oct. 7, 1903
Drowne, Henry Bernardin. Asst. Engr., R. I. State Board of Public Roads; Instr. in Civ. Eng., Brown Univ., Box 3, East Side Station, Providence, R. I.	Jun. Assoc. M.	Sept. 5, 1905 Mar. 4, 1908
Du Bois, Julian. Care, W. R. Grace & Co., Concepçion, Chili.		Jan. 8, 1902
Duder, John. Prin. Asst. City Engr., 1080 Third Ave., Salt Lake City, Utah		Nov. 8, 1909
Dufour, Frank Oliver. Asst. Prof. of Structural Eng., Univ. of Illinois, Urbana, Ill.	Jun. Assoc. M.	Dec. 5, 1899 Oct. 1, 1902
Duis, Frederick Bernhardt. U. S. Asst. Engr., East Liverpool, Ohio		Dec. 5, 1906
Duncan, James Harper. Searsport, Me.	Jun. Assoc. M.	Dec. 4, 1906 Feb. 1, 1910
Dunn, Emmett Clarke. City Engr., Alexandria, Va.		Nov. 4, 1891
Dunn, Herbert Luther. Constr. Supt., Gen. Elec. Pittsfield Plant, American House, Pittsfield, Mass.		Nov. 1, 1905
Dunn, William Robert. Civ. Engr. and Works Mgr., Vulcanite Portland Cement Co., Easton, Pa.		April 6, 1904

		Date of Membership.
Dunnells, Clifford George. Designing Engr., Am. Bridge Co., 1456 Frick Bldg. Annex, Pittsburg, Pa	Jun.	Feb. 4, 1902
	Assoc. M.	Jan. 2, 1907
Dutton, Charles Henry. Care, J. R. Worcester & Co., Waltham, Mass		Jan. 8, 1908
Easterbrooks, Preston Burt. Care, Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City		May 1, 1907
Eber, John William. 86 Mariner St., Buffalo, N. Y		Sept. 4, 1907
Eckart, Nelson Andrew. Res. Engr., Snow Mountain Water & Power Co., Potter Valley, Cal		Nov. 1, 1905
Eddy, Charles Wells. Res. Engr., Waterbury Water Supply, Thomaston, Conn		Mar. 2, 1909
Edelen, Thomas Jefferson Stone. Suite 302, Devon Court, Winnipeg, Man., Canada		July 1, 1909
Eder, Henry James. Cali, Colombia	Jun.	June 5, 1894
	Assoc. M.	Sept. 1, 1897
Edwards, Charles Milton. First Asst. Engr., Dept. of N. Y. State Engr., 43 Triangle Bldg., Rochester, N. Y		Sept. 2, 1908
Edwards, Frederick. Prof. of Civ. Eng., St. John's Military School, Manlius, N. Y.; Address, 369 Congress St., Troy, N. Y	Jun.	Jan. 31, 1899
	Assoc. M.	Feb. 5, 1902
Edwards, Oliver Cromwell, Jr. Pres., The Pneumatic Caisson Co., 2105 Fifteenth St., Troy, N. Y	Jun.	Oct. 7, 1902
	Assoc. M.	Dec. 5, 1906
Edwards, Warrick Rigeley. Asst. Engr. of Bridges, B. & O. R. R., Baltimore, Md		April 4, 1900
Egan, Louis Henry. Gen. Mgr., Rochester Light & Power Co., Rochester, Mich		Oct. 5, 1909
Ehrbar, Louis Harvey. Engr., Subway Constr., Plant Dept., N. Y. Telephone Co., 15 Dey St., New York City		May 2, 1906
Elbury, Thomas George. Municipal Contr., Suite 413, Mack Bldg., Denver, Colo		May 6, 1908
Eld, Charles John, Jr. Care, The Birmingham Water Works Co., R. F. D. No. 1, Leeds, Ala		May 6, 1903
Elliott, James William. 17 Adsit Pl., Burlington, Vt		April 6. 1909
Elliott, John Stuart. Civ. and Min. Engr., Care, B. B. Lawrence, 60 Wall St., New York City		April 6, 1892
Elliott, Malcolm. Asst. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Jun.	Nov. 5. 1907
	Assoc. M.	April 6, 1909
Ellis, Charles Alton. Asst. Prof. of Civ. Eng., Univ. of Michigan; Bridge Engr., Room 320, New Engineering Bldg., Ann Arbor, Mich		April 3. 1907
Ellis, Guernsey William. Care, Turner Constr. Co., Ellicott Sq. Bldg., Buffalo, N. Y		Nov. 4, 1908

		Date of Membership.
Elrod, Henry Exall. Gen. Mgr., Houston Structural Steel Co., 2906 Caroline St., Houston, Tex.		Nov. 7, 1906
Ely, Carl Brandes. Pennsylvania Steel Co., Steelton, Pa.		April 3, 1907
Ely, John Andrews. Structural Engr., 90 Morningside Ave., W., New York City	Jun. Assoc. M.	April 30, 1901 Jan. 8, 1908
Ely, John Stanton. Engr. in Chg., Queen Lane Filter Plant, Germantown, Philadelphia, Pa.		Mar. 2, 1904
Emerson, George Dana. Asst. Engr., Boston Transit Comm., 15 Beacon St., Boston, Mass.		June 3, 1908
Engle, Charles Algernon. Engr., Great Shoshone & Twin Falls Power Co., Bliss, Idaho	Jun. Assoc. M.	May 5, 1908 Oct. 5, 1909
Engström, Frans. City Engr., Altoona, Pa.		May 4, 1892
Ensign, Guert William. Asst. State Highway Commr., Harrisburg, Pa.		Nov. 4, 1908
Enzian, Charles. Div. Engr., Wyoming Div., Lehigh Val. Coal Co., 204 Coal Exchange Bldg. (Res., 375 So. River St.), Wilkes-Barre, Pa.	Jun. Assoc. M.	Sept. 3, 1901 Mar. 1, 1905
Espenshade, Edward Bowman. Asst. Engr., The Dolese Shepard Co. (Res., 6354 Greenwood Ave.), Chicago, Ill.		Nov. 6, 1907
Estes, Franklin Edward. Box 202, Manzanillo, Cuba		Feb. 7, 1906
Etcheverry, Bernard Alfred. Agriculture Bldg., Univ. of California, Berkeley, Cal.		June 1, 1909
Evans, John Edward. Asst. Engr., Detroit River Tunnel Co., 84 Trumbull Ave., Detroit, Mich.		Nov. 8, 1909
Evans, John Maurice. Treas., Cooper & Evans Co., Gen. Contrs., 220 Broadway, New York City	Jun. Assoc. M.	May 4, 1897 Jan. 3, 1900
Evans, Peter Platter. Contr. Engr., The Osborn Eng. Co., Cleveland, Ohio	Jun. Assoc. M.	Feb. 6, 1894 Mar. 7, 1900
Everham, Arthur Cassidy. Asst. Tunnel Engr., Detroit River Tunnel Co., M. C. Depot, Detroit, Mich.	Jun. Assoc. M.	Feb. 6, 1906 June 5, 1907
Fain, James Rhea. Supt. of Constr., U. S. Public Bldgs., Johnson City, Tenn.		June 4, 1902
Fairchild, John Fletcher. Engineering Bldg., Mt. Vernon, N. Y.	Jun. Assoc. M.	April 5, 1892 Dec. 4, 1895
Falter, Philip Henry. Gen. Supt., Northern Aluminum Co., Ltd., Shawinigan Falls, Que., Canada		Mar. 7, 1906
Farley, William Sanborn. Gen. Contr. (Scott & Farley), 48 Bacon Bldg., Oakland, Cal.		Nov. 8, 1909
Farnham, Arthur Benjamin. Engr., Board of Public Works, Pittsfield, Mass.		Jan. 2, 1907
Farnham, Charles Henry. Div. Engr., Philippine Railway Constr., J. G. White & Co., Engrs. and Contrs., Cebu Div., Cebu, Philippine Islands		June 1, 1904

		Date of Membership.
Farnham, Robert, Jr. Asst. Engr. of Constr., P. R. R., Union Station, Washington, D. C.		July 9, 1906
Farquhar, Henry Stilson. Bryn Mawr, Pa.	Jun. Assoc. M.	April 5, 1892 Nov. 4, 1896
Farrin, James Moore. Engr. of Bridges and Bldgs., Cuba R. R., Camagüey, Cuba		Nov. 30, 1909
Federlein, Walter Gottlieb. 2644 Marion Ave., New York City	Jun. Assoc. M.	Jan. 2, 1906 Feb. 2, 1909
Fenkell, Neal Charles. Chagrin Falls, Ohio		Dec. 1, 1908
Fenstermaker, DeWitt Clinton. City Engr., Tulsa, Okla.		Jan. 8, 1908
Fenton, Louis Gillespie. Asst. Engr. Designer, Board of Water Supply, 299 Broadway, New York City		Feb. 1, 1905
Ferguson, James Easton. Constr. Engr., The Toledo Massillon Bridge Co., Toledo, Ohio		June 1, 190
Ferguson, William Hastings. Prince Rupert, B. C., Canada.		Jan. 7, 190
Ferradas, Ramiro. Care, Sociedad de Ingenieros, Lima, Peru	Jun. Assoc. M.	Jan. 3, 1905 Mar. 7, 1906
Ferris, Frederick Edward. Asst. Engr., R. T. R. R. Comm., 231 West 125th St., New York City (Res., 820 Montgomery St., Jersey City, N. J.)		June 1, 1898
Field, Frederick Elbert. Prin. Div. Engr., Bureau of Filtration, Pittsburg, Pa.		Oct. 7, 1903
Fineren, William Warrick. Junior U. S. Engr., U. S. Engr. Office, Federal Bldg., Tampa, Fla.		Oct. 5, 1909
Firth, Elmer Wallace. Asst. Engr., Bureau of Sewers, Borough of Queens, New York City; Res., 1 John St., Jamaica, N. Y.	Jun. Assoc. M.	Jan. 7, 1896 Nov. 7, 1906
Firth, Joseph. City Engr., Charlotte, N. C.		June 5, 1907
Fischer, Theodore Christian. 1018 E. Grand St., Elizabeth, N. J.		Dec. 4, 1907
Fisher, Chester Centennial. Asst. Engr., U. S. Reclamation Service, Boise, Idaho	Jun. Assoc. M.	April 3, 1906 Oct. 2, 1907
Fisher, Howell Tracy. 5235 Archer St., Germantown, Philadelphia, Pa.		Nov. 1, 1905
Fisher, Wager. Civ., Elec. and Mech. Engr., 1516 Commonwealth Bldg., Philadelphia, Pa.	Jun. Assoc. M.	Oct. 3, 1899 Nov. 6, 1907
Fisk, Clinton Hinckley. Cons. Engr., 1424 Syndicate Trust Bldg., St. Louis, Mo.		June 5, 1907
Fitch, Squire Earnest. 10 Riley St., Westfield, N. Y.		July 9, 1906
FitzGerald, Christopher Columbus. Chf. Engr., T. L. Huston Contr. Co., Zulueta 46, Havana, Cuba		Oct. 2, 1901
Fleming, Thomas, Jr. Prin. Asst. Engr. in Chg., Design and Constr. Section, Penna. Dept. of Health, Harrisburg, Pa.	Jun. Assoc. M.	Nov. 5, 1907 Oct. 5, 1909
Fletcher, Josiah Monk. Richmond, Jamaica		Oct. 4, 1905

		Date of Membership.
Focht, Louis. Engr. to State Board of Assessors; Cons. Engr., 12 Atterbury Ave., Trenton, N. J.		May 4, 1892
Fogg, Percival Morris. Asst. Engr., U. S. Reclamation Service, Rupert, Idaho		Nov. 6, 1907
Follansbee, Robert. Dist. Engr., U. S. Geological Survey, St. Paul, Minn.	Jun. Assoc. M.	Nov. 1, 1904 Oct. 7, 1908
Foote, Arthur Burling. Asst. Supt., North Star Mines Co., Grass Valley, Cal.		Mar. 1, 1905
Forbes, Murray. Greensburg, Pa.		June 5, 1907
Forchhammer, Herluf Trolle. Chf. Engr., Christiani & Willsen Co., Contrs., Aarhus, Denmark		Feb. 1, 1905
Ford, Robert Henry Persse. Prin. Asst. Engr., Mo. Pac. Ry., S. L., I. M. & S. Ry., Leased, Operated & Independent Lines, St. Louis, Mo.	Jun. Assoc. M.	Mar. 2, 1897 June 7, 1899
Forrest, Charles Needham. Maurer, N. J.		April 6, 1909
Forrest, George Munro. 280 Broadway, Room 259, New York City		Oct. 2, 1907
Fortney, Camden Page. Supervisor of Masonry, Gatun Locks, Gatun, Canal Zone, Panama	Jun. Assoc. M.	Oct. 2, 1906 Nov. 30, 1909
Foster, Mortimer. Archt. (Foster, Gade & Graham), 281 Fourth Ave., New York City		June 1, 1904
Foster, Thomas J. 1123 Broadway, New York City		Feb. 1, 1899
Fougner, Hermann. Mgr., Trussed Concrete Steel Co., 1 Madison Ave., New York City		Feb. 1, 1905
Fountain, Thomas Lilly. Civ. and San. Engr., The Fountain-Shaw Eng. Co., Houston, Tex.	Jun. Assoc. M.	April 2, 1907 April 6, 1909
Fowler, Frank George. Civ. Engr. and Contr., Mount Kisco, N. Y.		June 5, 1907
Fowler, Robert Lambert. 155 State St., Perth Amboy, N. J.		Feb. 2, 1909
Fox, Walter Gordon. Asst. Chf. Engr., Ferrocarril al Curaray, Ambato, Ecuador		Jan. 2, 1901
Foyé, Andrew Ernest. Pres., Andrew E. Foyé Co., 20 Broad St., New York City	Jun. Assoc. M.	May 2, 1893 Nov. 4, 1896
Frasquieri y Regueifero, Tranquilino. Havana, Cuba		Aug. 31, 1909
Frazee, John Hatfield. 516 West 183d St., New York City		Dec. 6, 1899
Freeman, Arthur Clarico, Jr. 239 Arcade Bldg., Norfolk, Va.		July 1, 1908
Freeman, Milton Harvey. Asst. Engr., Board of Water Supply, New York City, 135 East 63d St., New York City		July 1, 1909
Freitag, Joseph Kendall. Secy., A. B. Robbins Iron Co., 166 Devonshire St., Boston, Mass.		Jan. 3, 1900
French, Charles Rauch. Engr., Herrick Constr. Co., Box 67, Brooklyn, N. Y.		Oct. 7, 1908
French, Mansfield Joseph. Engr., M. of W., Utica & Mohawk Val. Ry. Co.; Engr., M. of W., Oneida Ry. Co., Electric Railway Bldg. (Res., 906 Sunset Ave.), Utica, N. Y.		July 9, 1906

		Date of Membership.
Frew, Robert Dickson Alison. Chelmer, near Brisbane, Queensland, Australia		June 1, 1898
Frey, Frank Edward. Engr. and Contr., 820 Georgia St., Vallejo, Cal		Oct. 3, 1906
Frick, Walter. Lewisburg, Union Co., Pa		Dec. 2, 1896
Frickstad, Walter Nettleton. 1212 Twelfth Ave., Oakland, Cal		June 5, 1907
Frink, Fred Goodrich. Prof., Railway Eng., Univ. of Oregon, Eugene, Ore		May 3, 1899
Frisell, Eric Hjalmar. Contr. Engr. with Milliken Bros., Inc., 468 West 145th St., New York City		June 5, 1907
Frost, George Sherman. Asst. Engr., Public Service Comm. for the First Dist., State of New York, 4 Court Sq., Brooklyn, N. Y.	Jun. Assoc. M.	April 2, 1901 Jan. 7, 1903
Fruit, John Clyde. Mgr., Milwaukee Plant, Am. Bridge Co., 17th and St. Paul Ave., Milwaukee, Wis	Jun. Assoc. M.	May 2, 1905 Dec. 4, 1907
Frye, Harley Edgar. U. S. Engr. Office, Zanesville, Ohio		June 1, 1909
Fucik, Edward James. Engr., Great Lakes Dredge & Dock Co., 1622 So. Sawyer Ave., Chicago, Ill		Oct. 2, 1907
Fuller, Andrew Daniel. Treas., Andrew D. Fuller Co., Contrs. and Engrs., 3 Hamilton Pl., Boston, Mass	Jun. Assoc. M.	Dec. 6, 1898 Jan. 6, 1904
Fuller, Carl Hamilton. Supt. and Engr., Cook Constr. Co., 518 Good Blk., Des Moines, Iowa	Jun. Assoc. M.	Mar. 5, 1901 Feb. 3, 1904
Fuller, Weston Earle. (Hazen & Whipple, Cons. Engrs.), 103 Park Ave., New York City		June 7, 1905
Furlow, Felder. Box 118, Birmingham, Ala		April 6, 1909

Galbreath, William Otto. Div. Engr., National Railways of Mexico, Calle Reforma No. 150, Monterey, N. L., Mexico		April 6, 1904
Gandolfo, Joseph Harrington. Civ. Engr. with J. G. White & Co., 43 Exchange Pl., New York City		Oct. 2, 1907
Gannett, Farley. Engr., Water Supply Comm. of Pennsylvania, Harrisburg, Pa		April 4, 1906
Gardiner, John Peden. Civ. and Hydr. Engr., 733 Central Bldg., Los Angeles, Cal		Mar. 7, 1906
Gardner, Randall Dunbar. Asst. Engr., Room 60, City Hall, Boston, Mass		May 1, 1907
Garman, Harry Otto. Associate Prof. of Civ. Eng., Purdue Univ., Lafayette, Ind	Jun. Assoc. M.	Feb. 28, 1905 Oct. 7, 1908
Garrett, John Thomas. Pres., Missouri Bridge & Iron Co., 1000 Fullerton Bldg., St. Louis, Mo		May 1, 1901

		Date of Membership.
Gartensteig, Charles. Asst. Engr., Bureau of Highways, Borough of the Bronx, 177th St. and Third Ave. (Res., 61 East 83d St.), New York City	Jun. Assoc. M.	Oct. 6, 1896 May 6, 1903
Gay, Leon Lincoln. Designing Engr., Sacramento Val. Irrig Co., Willows, Cal	Jun. Assoc. M.	Dec. 5, 1905 Oct. 2, 1907
Gayler, Ernest Rotteck. Civ. Engr., U. S. N., Navy Yard, Charleston, S. C		April 6, 1904
Gaylord, Laurence Timmerman. Box 672, Port Arthur, Tex.		Nov. 4, 1908
Gearhart, Walter Scott. Highway Engr., Manhattan, Kans.		June 3, 1908
Gellatly, John Thompson Bisset. Engr.-in-Chg., Bongolo Water-works Constr., Queenstown, Cape Colony, South Africa		Jan. 2, 1907
Gentner, Otto Henry, Jr. Chf. Engr., Phila. Fireproofing Co., 1341 Arch St., Philadelphia, Pa		Nov. 4, 1908
Gersbach, Edward Charles. Asst. Engr., U. S. Reclamation Service, Browning, Mont		June 1, 1909
Gibbs, Elbert Allan. Engr., McClintic Marshall Constr. Co., Pittsburg, Pa	Jun. Assoc. M.	Mar. 6, 1906 July 1, 1909
Gibson, William Loane. Engr. in Chg. of Surveys, Antofagasta á Bolivia Ry. Co., Oruro, Bolivia		May 6, 1908
Gideon, Abraham. Asst. Engr., Dept. of Sewer and Water-Works Constr., Manila, Philippine Islands		Sept. 3, 1902
Gifford, Lester Robinson. 94 Porter Bldg., Memphis, Tenn	Jun. Assoc. M.	Mar. 3, 1896 Dec. 3, 1902
Gilbert, Archibald Marvine. Asst. Engr., Twin Falls Salmon River Land & Water Co., Salmon River Dam, Twin Falls, Idaho		May 4, 1909
Gilbert, George Herbert. Asst. Engr., Constr. Dept., Southern Ry. Co., 907 Seventeenth St., Lynchburg, Va		June 3, 1908
Gildersleeve, George Snyder. Mgr., Sales-Eng. Dept., Trussed Concrete Steel Co. (Res., 421 Second Ave.), Detroit, Mich	Jun. Assoc. M.	Feb. 5, 1907 Aug. 31, 1909
Giles, Arthur Leonard. 1299 Fair Ave., Columbus, Ohio		Oct. 4, 1905
Giles, James Marvin. Prin. Asst. Engr., Porto Rico Irrig. Service, Guayama, Porto Rico		Sept. 2, 1908
Gilkey, Thomas Alvin. Cons. Engr., 709 Lawrence Savings & Trust Co. Bldg., New Castle, Pa		Oct. 3, 1900
Gillen, Walter Joseph. Asst. Engr., Board of Water Supply, New York City, Brown Station, Ulster Co., N. Y	Jun. Assoc. M.	Oct. 31, 1905 July 1, 1909
Gilman, Charles Edward. Civ. and Min. Engr., with Duryea, Haehl & Gilman, Cons. Engrs., 1314 Humboldt Bank Bldg., San Francisco, Cal	Jun. Assoc. M.	Oct. 6, 1903 Dec. 5, 1906

		Date of Membership.
GODDARD, HERBERT WILLARD. Mgr. of Reinforced Concrete Dept., R. H. Howes Constr. Co., 500 Fifth Ave., New York City	Jun. Assoc. M.	Jan. 3, 1905 Jan. 5, 1909
GOLDENBERG, MAURICE. Mgr. of Sales, Trussed Concrete Steel Co., Trussed Concrete Bldg., Detroit, Mich		Feb. 7, 1906
GOLDSMITH, NATHANIEL OLIVER. Care, The Weir Frog Co., Norwood, Ohio	Jun. Assoc. M.	June 2, 1886 June 6, 1900
GOODELL, JOHN STANTON. Engr., M. of W., Kwang-Tung Yueh-Han Ry. Co., Ltd., Wong Sha, Canton, China		Mar. 7, 1906
GOODMAN, JOSEPH. Asst. Engr., Dept. of Water Supply, Gas and Electricity, Borough of Brooklyn, 157 West 111th St., New York City		June 6, 1906
GOODMAN, LOUIS. Pres., The Wormser-Goodman Constr. Co., 2 Rector St., Room 520, New York City		Oct. 5, 1909
GOODRIDGE, JOHN WESLEY. Contr. Engr., Litchfield Constr. Co., 23 Flatbush Ave., Brooklyn, N. Y	Jun. Assoc. M.	Oct. 4, 1898 April 5, 1905
GOODSELL, DANIEL BERTHOLF. 593 Riverside Drive, New York City		May 6, 1908
GORDON, JOHN BLAKE. 1410 H St., N. W., Washington, D. C	Jun. Assoc. M.	Dec. 1, 1903 June 7, 1905
GOUGH, WILLIAM JOSEPH. Asst. Engr., Coronado Beach Co., San Diego, Cal		Mar. 4, 1908
GOW, CHARLES RICE. Civ. Engr. and Contr., 25 Montview St., West Roxbury, Mass		June 1, 1904
GOWEN, SUMNER. Asst. Engr., Phœnix Bridge Co., Phœnixville, Pa	Jun. Assoc. M.	May 2, 1899 June 4, 1902
GRADY, JOHN EDWARD. Engr., Lake Erie Div., Great Lakes Dredge & Dock Co., 1486 E. 116th St., Cleveland, Ohio		Dec. 6, 1905
GRAHAM, EDGAR MILLER. Cons. Civ. Engr., Muskogee, Okla		Oct. 5, 1909
GRAM, LEWIS MERRITT. Structural Engr., 1047 Spitzer Bldg., Toledo, Ohio		June 1, 1909
GRANT, KENNETH CROTHERS. Asst. Engr., Water Supply Comm. of Pennsylvania, Harrisburg, Pa		Feb. 2, 1909
GRANT, THOMAS HENRY. Red Bank, N. J		May 6, 1891
GRANT, ULYSSES S, 3RD. 1st Lieut., Corps of Engrs.; Supt., State, War and Navy Bldg., Washington, D. C		Aug. 31, 1909
GRAVELLE, ALVIN. Asst. Bridge Engr., 311 City Hall, Cleveland, Ohio		Nov. 6, 1901
GRAVES, WILLARD FRANKLIN. Engr. of Track Constr., Chicago City Ry. Co., 2020 State St., Chicago, Ill	Jun. Assoc. M.	Oct. 31, 1899 Jan. 4, 1905
GRAY, EDWARD. 622 Chemical Bldg., St. Louis, Mo		May 1, 1907
GRAY, EDWARD, JR. 474 Fourteenth Ave., S. W., Roanoke, Va		Jan. 2, 1895
GRAY, HENRY LILBURN. Engr., R. R. Comm. of Washington, Olympia, Wash		July 1, 1909

		Date of Membership.
Gray, John Lathrop. Supt., Paraffine and Lubricating Dept., Tide Water Oil Co., Bayonne, N. J.		Dec. 6, 1905
Gray, Walter Thomas. First Asst. Engr., Sewer Dept. (Res., 6908 Virginia Ave.), St. Louis, Mo.		Oct. 7, 1908
Gray, William. Asst. Engr., Bureau of Sewers, Borough of the Bronx, New York City	Jun. Assoc. M.	May 2, 1888 Mar. 1, 1893
Gray, William Bacon. Stone Ridge, N. Y.		Aug. 31, 1909
Gray, William David. 1237 South Garvin Pl., Louisville, Ky.		Oct. 7, 1908
Green, Andrew H. Roseau, Dominica, B. W. I.		Oct. 2, 1901
Green, Charles Newton. Asst. Engr., Public Service Comm., First Dist., 154 Nassau St., New York City		June 3, 1903
Green, Fred May. Office Engr., P. T. & T. R. R., East River Div., Pennsylvania Station, 32d St. and Seventh Ave., New York City		April 6, 1904
Green, James Arleigh. 640 South 7th St., Terre Haute, Ind.		Jan. 8, 1908
Green, James Cowan. 68 N. Allen St., Albany, N. Y.		April 6, 1909
Green, Paul Evans. Civ. and San. Engr., 125 La Salle St., Chicago, Ill.		July 10, 1907
Greenalch, Wallace. Commr. of Public Works, Albany, N. Y.	Jun. Assoc. M.	April 3, 1894 June 7, 1899
Greene, Albert Emerson. Junior Prof. of Civ. Eng., Univ. of Michigan, 415 E. William St., Ann Arbor, Mich.		May 4, 1904
Greene, Carleton. Mech. Engr., The Snare & Triest Co., 143 Liberty St., New York City		Mar. 3, 1897
Greene, Frederick Stuart. Vice-Pres. and Gen. Mgr., The Waterproofing Co., 150 East 36th St., New York City		June 7, 1899
Greene, Howard Arnold. Div. Erecting Mgr., Am. Bridge Co. of N. Y., 1525 Frick Bldg., Pittsburg, Pa.		June 5, 1895
Greene, William Stewart. 284 Redmond St., New Brunswick, N. J.		May 4, 1909
Greenman, Russell Soule. Res. Engr., Testing Laboratory, Dept. of N. Y. State Engr. and Surv., State Engr.'s Dept., State Hall, Albany, N. Y.		Aug. 31, 1909
Greensfelder, Albert Preston. Secy., Fruin-Colnon Contr. Co., 506 Merchants Laclede Bldg., St. Louis, Mo.	Jun. Assoc. M.	May 3, 1904 May 2, 1906
Greenwood, Albert Henry. Engr. for Berlin Constr. Co., 39 Capen St., Hartford, Conn.		Feb. 1, 1905
Gregory, Alfred Cookman. Engr. of Sewers (Res., 555 Rutherford Ave.), Trenton, N. J.		June 5, 1907
Gregory, Charles Emerson. Mt. Kisco, N. Y.	Jun. Assoc. M.	Oct. 6, 1896 Mar. 6, 1901
Griffin, Arthur James. Engr. of Constr., Bureau of Sewers, D. P. W., 2149 Clarendon Rd., Brooklyn, N. Y.		Dec. 7, 1904
Griffith, John Howell. Asst. Prof., Civ. Eng., Univ. of Michigan, 928 Oakland Ave., Ann Arbor, Mich.		April 3, 1907

		Date of Membership.
Griffith, Lawrence. Cons. Engr., Yonkers, N. Y.		May 2, 1900
Grimm, Henry England. P. O. Box 640, Chicago, Ill.	Jun. Assoc. M.	Oct. 2, 1900 Nov. 4, 1908
Griswold, Harry Todd. Care, Lozier Motor Co., Plattsburg, N. Y.	Jun. Assoc. M.	Oct. 6, 1903 Dec. 4, 1907
Griswold, Ray Elliott. Pres., Elk Creek Lumber Co., Cottage Grove, Ore.		Oct. 1, 1902
Gronwall, Thomas Hagen. Structural Engr. for C. C. Heisen, 225 Dearborn St., Room 529, Chicago, Ill.	Jun. Assoc. M.	Jan. 3, 1907 April 6, 1909
Gross, Charles Frederick. Engr. for Wm. Steele & Sons Co., 1600 Arch St., Philadelphia, Pa.		Sept. 2, 1908
Gross, Daniel Wingerd. Engr. of Constr., Atlantic Coast Line R. R. Co., Wilmington, N. C.		May 1, 1901
Grover, Nathan Clifford. Irrig. Engr., J. G. White & Co., Inc., 43 Exchange Pl., New York City		Mar. 2, 1904
Grover, Oscar Llewellyn. Asst. Engr., C. & O. Ry., 8th and Main Sts., Richmond, Va.		Mar. 2, 1909
Gubelman, Frederick Joseph. Pres., Eastern Constr. Co. of N. J.; Vice-Pres., O'Rourke Eng. Constr. Co., 1 West 34th St., New York City		Oct. 2, 1895
Gude, Albert Valdemar, Jr. 712 Prudential Bldg., Atlanta, Ga.		June 5, 1907
Gudewill, Charles Edward. Vice-Pres., Montreal Pipe Foundry Co., P. O. Box 2304, Montreal, Que., Canada		Sept. 1, 1897
Gudmundsson, Gisli. Empire Bldg., Pittsburg, Pa.		Jan. 3, 1900
Gueringer, Louis Amedee. Chf. Engr., Port O'Connor, Rio Grande & Northern Ry., Victoria, Tex.		May 7, 1902
Guise, Philip. Asst. Engr., Dept. of Docks and Ferries, Gowanus Section Office, Ft. of 32d St., Brooklyn, N. Y.		Nov. 6, 1907
Gundersen, August. Hangeveien 40, Bergen, Norway		Oct. 2, 1907
Gustafson, Gustaf Edward. Bldg. Constr. Engr., Board of Education, 974 Cuyler Ave., Chicago, Ill.		July 10, 1907
Gustin, R Prosper. 285 Rich Ave., Mt. Vernon, N. Y.		May 1, 1907
Guthrie, Keith Osmond. Eng. Contr., 1073 Dean St., Brooklyn, N. Y.		May 3, 1905
Haas, Philip Lippman. State Road Engr., 359 Keyes Ave., Watertown, N. Y.		May 6, 1908
Hadsall, Joseph Canby. Wheatland, Wyo.		Nov. 8, 1909
Hadwen, Theodore Lovel Donner. Engr. of Masonry Constr., Bridge and Bldg. Dept., C., M. & St. P. Ry., 1359 Railway Exchange, Chicago, Ill.		Oct. 7, 1908
Haehl, Harry Lewis. With Duryea, Haehl & Gilman, 1314 Humboldt Bank Bldg., San Francisco, Cal.	Jun. Assoc. M.	Oct. 6, 1903 July 9, 1906

		Date of Membership.
Hagar, Edward McKim. Pres., Universal Portland Cement Co., 1434 Commercial Bank Bldg., Chicago, Ill.		Feb. 6, 1901
Hager, Albert Bertram. Public Service Comm., 154 Nassau St., New York City (Res., 36 Addison Ave., Rutherford, N. J.)		Nov. 1, 1905
Haggart, Cecil Neil. 79 N. Allen St., Albany, N. Y.		May 6, 1908
Haight, Horace De Remer. Engr. for Thos. Prosser & Son, 15 Gold St., New York City; Address, 488 Western Ave., Albany, N. Y.	Jun. Assoc. M.	May 1, 1900 Feb. 4, 1903
Hain, James C. Care, The Snare & Triest Co., 143 Liberty St., New York City		May 1, 1901
Haines, Eugene Grove. Asst. Engr., Public Service Comm., First Dist., Fifth Div., New York City, 4 Court Sq., Brooklyn, N. Y.		May 1, 1901
Haldeman, Walter Stanley. 1105 Diamond St., Philadelphia, Pa.		Oct. 5, 1909
Hale, Richard King. Cons. Engr. (Richardson & Hale), 85 Water St., Boston, Mass.	Jun. Assoc. M.	April 4, 1905 Feb. 1, 1910
Hall, Charles Romney. 1005 Hooker & Lent Bldg., San Francisco, Cal.		Jan. 7, 1903
Hall, Louis Wells. Engr., U. S. Reclamation Service, Fallon, Nev.		Oct. 1, 1902
Hall, Martin Welch. Asst. Engr., Bureau of Sewers, Borough of the Bronx, New York City	Jun. Assoc. M.	Oct. 1, 1901 Nov. 7, 1906
Halsey, Edmund Ryond. 164 Market St., Newark, N. J.		Feb. 7, 1906
Hamill, Alexander Sylvester. 426 Montgomery St., Jersey City, N. J.	Jun. Assoc. M.	Dec. 28, 1900 April 6, 1909
Hamilton, Farrar Petrie. Mgr., Hamilton Constr. Co., 308 S. Eighth St., St. Louis, Mo.		June 3, 1908
Hamlin, Ralph. Asst. Engr., Corrugated Bar Co., 710 Pioneer Press Bldg., St. Paul, Minn.	Jun. Assoc. M.	Jan. 5, 1904 Oct. 5, 1909
Hancock, Lewis Wernette. Local Mgr., Fruin Colnon Cont. Co.; Address, 820 South Brook St., Louisville, Ky.		Jan. 2, 1907
Haney, Lewis Tustler. 1 Crooke Ave., Brooklyn, N. Y.	Jun. Assoc. M.	Oct. 7, 1902 Mar. 1, 1905
Hanna, Walter Scott. Asst. Engr., Pennsylvania Dept. of Health, Harrisburg, Pa.	Jun. Assoc. M.	Oct. 6, 1903 June 5, 1907
Hansell, William Albert. Civ. Engr. and Supt. of Constr., 630 Highland Ave., Atlanta, Ga.		Oct. 5, 1909
Hansen, Paul. Asst. Engr. of the Ohio State Board of Health, 912 Harrison Bldg., Columbus, Ohio	Jun. Assoc. M.	Jan. 3, 1905 April 1, 1908
Harbeck, Henry Russell. Engr. and Supt. of Constr., Leonard Constr. Co., 1417 Monadnock Blk., Chicago, Ill.		June 3, 1908

		Date of Membership.
C. **Harby, Isaac.** Civ. Engr. for John A. Roebling's Sons Co., Trenton, N. J.	Jun. Assoc. M.	June 6, 1899 May 6, 1903
Hardesty, James Robert. Mgr., Virginia Bridge & Iron Co., 707 Hibernia Bank Bldg., New Orleans, La.		Feb. 2, 1909
Hardin, Abraham Tracy. Asst. Gen. Mgr., N. Y. C. & H. R. R. R. Co., Grand Central Station, New York City		Mar. 2, 1904
Harding, Robert John. Supt. of Public Works, Poughkeepsie, N. Y.		Nov. 4, 1908
Harding, William Stewart. Bituminous Coal Operator, Arcade Bldg. (Res., 3411 Hamilton St.), Philadelphia, Pa.	Jun. Assoc. M.	Nov. 3, 1896 Oct. 3, 1906
Hardison, Allen Crosby. Civ. and Min. Engr., Santa Paula, Cal.		Feb. 6, 1901
Hardman, Roy Cordis. Civ. Engr. and Supt. of Constr., War Dept., Fort Crockett, Galveston, Tex.		Oct. 7, 1908
Hardt, Charles William. Camp Hill, Cumberland Co., Pa.		July 1, 1909
Harlow, James Hayward, Jr. Asst. Engr., Susquehanna Power Co., Darlington, Harford Co., Md.		Mar. 5, 1902
Harman, Jacob Anthony. Agricultural and San. Drainage, 120 Fredonia Ave., Peoria, Ill.		May 4, 1898
Harper, Isaac Onward. Secy. and Treas., Lauer & Harper Co., Baltimore, Md.		May 7, 1902
Harps, Harry Macy. Nantucket, Mass.	Jun. Assoc. M.	Mar. 3, 1903 Oct. 2, 1907
Harrington, Allan Collins. Cons. Engr., 518 N. Illinois St., Indianapolis, Ind.		Oct. 2, 1907
Harrington, Francis Burchard. Trainmaster, N. Y. C. & H. R. R. R., Union Station, Albany, N. Y.	Jun. Assoc. M.	Sept. 11, 1900 Feb. 5, 1908
Harrington, Harry Garfield. Eng. Dept., The New Jersey Zinc Co., 71 Broadway, New York City	Jun. Assoc. M.	Jan. 7, 1902 Feb. 7, 1906
Harris, Borden Baker. Asst. Chf. Engr., J. G. White & Co., Inc., Philippine Railway Constr., Iloilo, Philippine Islands		April 3, 1907
Harris, Guy Walter. Chf. Engr. of Constr., The Pecos & Northern Texas Ry. Co., Amarillo, Tex.		June 5, 1907
Harris, Henry Alexander. Care, Direccion General de Obras Publicas de la Republica Dominicana, Santo Domingo, Santo Domingo.	Jun. Assoc. M.	Oct. 31, 1899 June 7, 1905
Harris, Jay Butler. Reinforced Concrete Engr., 1201 West 7th St., Los Angeles, Cal.		Oct. 2, 1907
Harshbarger, Elmer Dwight. Engr., Pitt Constr. Co., 821 Fulton Bldg., Pittsburg, Pa.	Jun. Assoc. M.	Nov. 5, 1901 Jan. 3, 1906
Hart, Reuben Charles. Howes Blk., Clinton, Iowa		Sept. 2, 1908

		Date of Membership.
Hartman, Alfred Hanson. Asst. Div. Engr., Sewerage Comm., 908 American Bldg., Baltimore, Md.	Jun. Assoc. M.	Dec. 6, 1904 Dec. 5, 1906
Hartman, August Frederick. Chf. Draftsman, Geo. F. Hardy, 309 Broadway, New York City		Dec. 4, 1907
Hartman, Russell Theodore. Care, Des Moines Bridge & Iron Works, Des Moines, Iowa		May 4, 1909
Hasbrouck, Oscar. 136 Saratoga Ave., Northside, Cohoes, N. Y.	Jun. Assoc. M.	Jan. 3, 1907 Nov. 8, 1909
Haskell, Frank Hampton. Asst. Engr., Burton Constr. Co., 220 S. 3d St., Richmond, Va		Jan. 8, 1908
Hastings, Frank Arnold. Chf. Engr., Riverside Bridge Co., P. O. Box 312, Martins Ferry, Ohio		Dec. 3, 1902
Hatt, William Kendrick. Prof. of Civ. Eng., Purdue Univ.; Civ. Engr., Forest Service, U. S. Dept. of Agriculture Lafayette, Ind		June 4, 1902
Hattan, William Cary. Kerrs Creek, Va		Nov. 6, 1907
Hatton, Herbert Watson. Care, T. Chalkley Hatton, 302 Equitable Bldg., Wilmington, Del	Jun. Assoc. M.	April 4, 1905 June 1, 1909
Hauck, William. Asst. Engr., Aqueduct Comm., New York City; Address, Brewster, N. Y		June 5, 1901
Havens, Ralph DeWitt. 155 Prospect St., Bristol, Conn		Aug. 31, 1909
Havens, Verne LeRoy. Chf. Engr., Elec. Tramways, 4a Puente de Alvarado 92, City of Mexico, D. F., Mexico	Jun. Assoc. M.	Oct. 3, 1905 April 1, 1908
Hawes, Louis Edwin. Civ. and Hydr. Engr., 101 Tremont St., Boston, Mass		Sept. 2, 1896
Hawkesworth, John. 100 West 80th St., New York City	Jun. Assoc. M.	Sept. 6, 1904 Nov. 4, 1908
Hawkins, Irving. 105 Milligan Pl., South Orange, N. J		May 6, 1908
Hawley, George Prince. Cons. Engr., De Pere, Wis		Feb. 6, 1901
Hawn, Russell John. Supt., Virginia Portland Cement Co., Fordwick, Va.		Nov. 30, 1909
Hayden, Edwin Clapp. 16 City Sq., Room 4, Charlestown, Mass	Jun. Assoc. M.	Oct. 1, 1901 June 7, 1905
Hayes, Morgan Dodge. 565 West 113th St., New York City		April 1, 1903
Hayes, Ralph Daniel. Asst. Engr., New York State Barge Canal, Stillwater, N. Y.	Jun. Assoc. M.	June 4, 1907 Aug. 31, 1909
Haylow, James Henry. Engr. in Chg. of Constr., The Memphis St. Ry. Co., Memphis, Tenn		Dec. 5, 1906
Haynes, Claude Sanford. Asst. Engr., Bureau of Sewers, 215 Montague St., Room 916, Brooklyn, N. Y		Jan. 4, 1910
Haynes, George Albert. Engr. and Gen. Mgr., Stone City Steel Constr. Co., Bedford, Ind		Sept. 2, 1908

		Date of Membership.
Hays, Don. Dist. Engr., C., M. & P. S. Ry., 256 Front Ave., Spokane, Wash		May 6, 1903
Hayt, Robert Olcott. Asst. Engr., U. S. Reclamation Service, Helena, Mont		Oct. 3, 1906
Hazard, Erskine. Mauch Chunk, Pa		Oct. 2, 1895
Hazard, William Abbott. Mgr., Lackawanna Bridge Co., P. O. Box 97, Buffalo, N. Y		Nov. 8, 1909
Hazelton, William Sylvester. 475 Second Ave., Detroit, Mich		May 4, 1909
Hazlett, Robert. City Bank Bldg., Wheeling, W. Va		Mar. 4, 1896
Heald, Edward Creswell. Chf. Structural Engr., Office of Superv. Archt., Treasury Dept., Washington, D. C	Jun. Assoc. M.	Oct. 7, 1902 May 2, 1906
Hebard, Roy William. (Hebard & Alberts), Bohio, Canal Zone, Panama		Feb. 6, 1907
Heck, Nicholas Hunter. Asst., U. S. Coast and Geodetic Survey, Washington, D. C		July 1, 1909
Heckle, George Rogers. Brent Bldg., Pensacola, Fla		Feb. 7, 1906
Heer, William, Jr. U. S. Junior Engr., Pennington, Ala	Jun. Assoc. M.	Nov. 5, 1907 April 6, 1909
Heiges, Thomas Tyrrell. 47 E. Market St., York, Pa		Feb. 5, 1908
Heindle, William Albert. Asst. Engr., J. G. White & Co., 43 Exchange Pl., New York City		Nov. 6, 1901
Heller, John Walter. Eng. Contr., 738 Broad St., Newark, N. J		June 6, 1906
Henderson, Adelbert Andrew. County Engr.'s Office, Room 25, Court House, Pittsburg, Pa		April 4, 1906
Henderson, Samuel Whilden. Mgr., The Ecelsior Springs Light, Power, Heat & Water Co., The Excelsior Water Co., The Marysville Light, Power & Water Co., Marysville, Kans		Sept. 6, 1905
Hendricks, Victor King. Office Engr., Frisco Lines, St. Louis, Mo		May 1, 1895
Henry, Francis Maxwell. Lumber Exchange, Minneapolis, Minn		Mar. 4, 1896
Hermanns, Frank Edward. Senior Asst. Engr., Tientsin-Pukow Line, Chinese Imperial Railways, Nanking, China.		Jan. 3, 1906
Herrick, John James. Dept. of Docks and Ferries, Foot West 56th St., New York City		June 6, 1900
Herring, Jerome Campbell. Civ. and Cons. Engr.; Chf. Engr., Kansas City-Southeastern Traction Co., Kansas City, Mo.		April 5, 1905
Hersey, Guy Alfred. Civ. Engr. and Surv., Bass Blk., Room 19, Bangor, Me	Jun. Assoc. M.	June 4, 1907 Oct. 7, 1908
Hewat, Henry John. 227 Hamilton Ave., Paterson, N. J		April 3, 1907
Hewitt, George. Care, Lee & Hewitt, 1123 Broadway, New York City		Oct. 3, 1906

		Date of Membership.
HIGGINS, CHARLES HOUCHIN. Cons. and Const. Engr., Commercial Trust Co. Bldg., Jersey City, N. J.	Jun. Assoc. M.	Jan. 2, 1906 April 1, 1908
HIGGINS, HERMAN KEENE. Cons. Engr., 1105 Exchange Bldg., Boston, Mass		Nov. 7, 1906
HIGGINS, JAMES WALLACE. Civ. and Landscape Engr., 347 Fifth Ave., New York City (Res., Roselle Park, N. J.)		April 3, 1907
HIGGINSON, JONATHAN YATES. Res. Engr., N. Y., N. H. & H. R. R., 88 Center St., New Rochelle, N. Y	Jun. Assoc. M.	Oct. 1, 1901 Nov. 8, 1909
HIGHLEY, LEE. Asst. Engr., Mo. Pac. Ry., 1265 Hamilton Ave., St. Louis, Mo	Jun. Assoc. M.	Dec. 7, 1897 Dec. 4, 1901
HILDRETH, JOHN LEWIS, JR. Asst. Engr. in Chg. of Section 4, Moodna Siphon, Board of Water Supply, Vailsgate, N. Y		Dec. 6, 1905
HILL, EDWIN ALLSTON. Asst. Examiner, U. S. Patent Office, Washington, D. C		May 3, 1893
HILL, GEORGE SAMUEL. Cons. Engr. (Lathrop & Hill), 1305 Call Bldg., San Francisco, Cal	Jun. Assoc. M.	Jan. 3, 1907 June 1, 1909
HILL, THEODORE WILLIAM. Contr. Engr., Bellefontaine, Ohio		Mar. 7, 1900
HILL, WALTER ARTHUR. Chf. Engr. and Supt., Vera Cruz & Pacific R. R., Calle Real de Churubusco No. 13, Churubusco, D. F., Mexico		Sept. 2, 1896
HILLER, JOHN AUGUSTUS. Supt. of Distrib., City Water Dept., City Hall, Cincinnati, Ohio		Sept. 7, 1904
HILLMAN, GEORGE WALDO. Asst. Engr., Tex. & Pac. Ry. Co., Boyce, La		April 1, 1908
HILTON, HARRY LEGRAND. 24 Overlook Pl., Newburgh, N. Y		June 1, 1909
HILTON, JOSEPH CHURCHILL. Supt., T. M. McLeod, Co., 90 West St., New York City		Jan. 2, 1907
HIRST, ARTHUR. Engr., Trenton Plant, Am. Bridge Co., Trenton, N. J		Dec. 3, 1902
HITCHMAN, JACKSON COLBORN. Cuatotolápam, Ver., Mexico		Oct. 5, 1904
HOAD, WILLIAM CHRISTIAN. Associate Prof. of Civ. Eng., Univ. of Kansas, Lawrence, Kans		Dec. 5, 1906
HODGDON, BENJAMIN ALEXANDER. Asst. Engr., Public Service Comm. for 1st Dist., State of New York, 154 Nassau St., New York City		Mar. 2, 1909
HODGDON, JOHN BREWSTER. City Engr.; Asst. Engr., Mo., Kans. & Tex. Ry. Co., 2101 Wall St., Joplin, Mo		April 3, 1907
HODGMAN, HARRY. U. S. Junior Engr., Amherstburg, Ont., Canada		Mar. 2, 1904
HOFFMAN, WILLIAM OTTO. Care, Board of Education, 500 Park Ave., New York City		Jan. 8, 1908
HOGUE, CHARLES JAY. 5720 Walnut St., Philadelphia, Pa		Dec. 7, 1898

		Date of Membership.
Hogue, Chester James. Const. Engr., Eastern Concrete Constr. Co., Paddock Bldg., Boston, Mass		Dec. 6, 1905
Holbrook, Percy. Vice-Pres., The Rail Joint Co., 29 West 34th St., New York City		Mar. 2, 1898
Holdrege, Henry Atkinson. Gen. Mgr., Omaha Elec. Light & Power Co., Omaha, Nebr		Dec. 7, 1904
Holley, Carl Hiram. Cons. Hydr. and Elec. Engr., First National Bank Bldg., Visalia, Cal		June 5, 1907
Holley, Harry Hall. Visalia, Cal		Oct. 5, 1909
Holliday, Alexander Rieman. Secy., The National Concrete Co., 805 Traction Terminal Bldg., Indianapolis, Ind	Jun. Assoc. M.	Oct. 7, 1902 Feb. 1, 1905
Holmes, Edwin Merritt. Gen. Supt., The Juragua Iron Co., Firmeza, Santiago de Cuba, Cuba	Jun. Assoc. M.	Mar. 31, 1903 Jan. 2, 1907
Holmes, Frank. Asst. Engr., Thompson-Starrett Co., 51 Wall St., New York City		Dec. 1, 1908
Holt, Lester Morton. Project Engr., Tongue River Irrig. Project, Birney, Mont		Oct. 3, 1906
Holtsmark, Erling. Public Service Comm., 154 Nassau St., New York City		April 1, 1908
Holtzman, Stephen Ford. 11 East 24th St., New York City		Mar. 7, 1906
Homan, William MacLean. Cons. Engr. and Govt. Land Surv., Bethlehem, Orange River Colony, South Africa		June 7, 1899
Honness, George Gill. Div. Engr., Board of Water Supply, Pleasantville, Westchester Co., N. Y	Jun. Assoc. M.	Feb. 2, 1897 Sept. 4, 1901
Hood, Hugh Kendall. Res. Engr. for B. H. Hardaway, Blacksburg, S. C		Feb. 1, 1910
Hood, John Mifflin, Jr. Chf. Engr., United Rys. & Elec. Co., 1008 Continental Trust Bldg., Baltimore, Md	Jun. Assoc. M.	May 31, 1904 June 6, 1906
Hood, Joseph Nelson. Engr., Pittsburg Contr. Co., 236 Grand St., Newburgh, N. Y		April 3, 1907
Hopkins, Albert Lloyd. Asst. Gen. Mgr., Newport News Shipbuilding & Dry Dock Co., Newport News, Va	Jun. Assoc. M.	April 3, 1894 April 3, 1901
Hopkins, Newton Fisher. With Harrop, Hopkins & Taylor, 900 Lewis Bldg., Pittsburg, Pa		Oct. 2, 1907
Horne, Harold Wellington. Asst. Engr., Board of Water Supply, City of New York, Cornwall-on-Hudson, N. Y		Oct. 2, 1907
Horstman, Joseph Prosper. Engr. and Gen. Supt., Parkersburg, Marietta & Inter-Urban Ry. Co., Parkersburg, W. Va		Dec. 7, 1904
Hortenstine, Henry Roberts. Agt., Penn Bridge Co., Key West, Fla		April 3, 1907

		Date of Membership.
Horton, Albert Howard. Dist. Engr., U. S. Geological Survey, Federal Bldg., Newport, Ky.	Jun. Assoc. M.	June 3, 1902 Mar. 6, 1907
Horton, Dwight Fred. Vice-Pres., J. W. Maxey Co., 906 Scanlan Bldg., Houston, Tex.	Jun. Assoc. M.	June 6, 1905 Feb. 5, 1908
Horton, Robert Elmer. 57 North Pine Ave., Albany, N. Y.		Dec. 7, 1904
Hosmer, Guy Frederic. With O. Perry Sarle, 146 Westminster St., Providence, R. I.		Nov. 6, 1907
Hough, Frederick Milton. Contr. Engr., San Juan, Tex.		Nov. 6, 1907
Hovey, Ray Palmer. With Minneapolis Steel & Machinery Co., 324 Dooley Blk., Salt Lake City, Utah	Jun. Assoc. M.	Jan. 2, 1906 Nov. 8, 1909
How, Richard Willis. Asst. Engr., L. I. R. R., Jamaica, N. Y.	Jun. Assoc. M.	June 6, 1899 Mar. 1, 1905
Howalt, Wilhelm Jens Christian. 512 West 156th St., New York City		June 5, 1907
Howard, Conway Robinson. Engr., Great Southern Lumber Co., and New Orleans, Great Northern R. R., P. O. Box 622, Bogalusa, La.		Dec. 5, 1906
Howard, Ernest Emmanuel. With Waddell & Harrington, Cons. Engrs., 10th Floor, Orear-Leslie Bldg., Kansas City, Mo.	Jun. Assoc. M.	Dec. 3, 1901 Sept. 6, 1905
Howard, Lewis Thomas. Asst. Engr., New York Barge Canal, Schuylerville, N. Y.		June 3, 1908
Howe, Charles Edward. With Hastings Pavement Co., Hastings-on-Hudson, N. Y.	Jun. Assoc. M.	Mar. 6, 1900 May 3, 1905
Howe, Herbert Frank. 9 Miller Ave., North Cambridge, Mass.		Oct. 2, 1907
Howell, Frank Scott. Civ. Engr. in Chg., U. S. Immigrant Station, Ellis Island, New York Harbor, N. Y. (Res., New York Athletic Club, Central Park South, New York City)		April 4, 1906
Howell, Robert Parsons. Town Surv. and Civ. Engr., 41 Brainard St., Phillipsburg, N. J.		Oct. 4, 1905
Howell, William Augustus. Engr., Streets and Highways, City Hall, Newark, N. J.		April 3, 1907
Hoyt, Henry Perez. Care, Great Northern Paper Co., Millinocket, Me.	Jun. Assoc. M.	Oct. 6, 1903 Dec. 4, 1907
Hoyt, John T Noye. Archt.; Structural Engr., 406 Prudential Bldg., Buffalo, N. Y.	Jun. Assoc. M.	Feb. 28, 1893 Mar. 2, 1898
Hubbard, Winfred Dean. 242 Washington Ave., Kingston, N. Y.		Nov. 5, 1902
Hubbell, George Scott. 319 Lincoln St., Flushing, N. Y.		June 1, 1904
Hudson, Harold Walton. Asst. Engr., Sunnyside Yard, P. T. & T. R. R., Box 348, Woodside, N. Y.		May 3, 1905
Huestis, Charles Calvin. Secy. and Gen. Mgr., Essex Constr. Co., 442 Prudential Bldg., Buffalo, N. Y.		Mar. 6, 1901

		Date of Membership.
Huff, Clyde Leslie. Engr., Big Lost River Land & Irrig. Co.; Care, The Arnold Co., Moore, Idaho		July 1, 1909
Hughes, Francis Dey. Contr. Engr., Illinois Steel Bridge Co., Room 6, Central Bldg., Kansas City, Mo		Sept. 3, 1902
Hulse, Shirley Clark. Field Engr., Second Clackamas Development, Cazadero, Ore	Jun. Assoc. M.	Oct. 7, 1902 Feb. 6, 1907
Humphreys, Clifton Stewart. Engr. (Snow & Humphreys), Madison, Me		May 2, 1900
Hunicke, William August. Chf. Engr. and Supt., Morey-Faulhaber Constr. Co., Apalachicola, Fla		Mar. 2, 1904
Hunt, Charles Adams. Care, Public Service Comm., 154 Nassau St., New York City		Oct. 4, 1905
Hunt, Leigh Anson. Pres. & Gen. Mgr., Hunt Eng. Co., Iola, Kans		Feb. 6, 1907
Hunt, Loren Edward. Asst. Engr., Dept. of Public Works, 38 Sixth Ave., San Francisco, Cal		June 3, 1903
Hunter, Adam. Chf. Engr. to *Sir* Wm. Arrol & Co., Ltd., 85 Preston St., Bridgeton, Glasgow, Scotland		Sept. 6, 1905
Hunter, John. Care, Brown-Hunter Co., 407 Dollar Bank Bldg., Youngstown, Ohio		Feb. 6, 1907
Hunter, Robert Easton. 2320 Mance St., Montreal, Que., Canada		Nov. 6, 1901
Hunter, Thomas Benton. Res. Engr., Monterey County Water-Works, Monterey, Cal	Jun. Assoc. M.	April 4, 1905 July 1, 1909
Hunting, Eugene Nathan. Reinforced Concrete Engr. for Nicola Bldg. Co., 2115 Farmers Bank Bldg., Pittsburg, Pa	Jun. Assoc. M.	Nov. 1, 1904 April 1, 1908
Huntington, George Danforth. Pres., Raquette Foundry & Supply Co., Massena, N. Y		Dec. 7, 1904
Hurlbut, Charles Chase. Engr. with Kenneth M. Murchison, Archt., 320 Fifth Ave., New York City		Dec. 5, 1906
Hurlbut, Hinman Barrett. 93 Quitman St., Newark, N. J.		July 1, 1909
Huston, Tillinghast L'Hommedieu. Gen. Contr., Zulueta 46, Havana, Cuba		May 2, 1900
Hutchins, Edward. East Walpole, Mass	Jun. Assoc. M.	June 6, 1905 Jan. 4, 1910
Hyatt, Caleb. Care, Harlem Contr. Co., 201st St. and 9th Ave., New York City	Jun. Assoc. M.	Mar. 3, 1903 April 5, 1905
Hyde, Howard Elmer. First Engr., Office of Chf. Engr., Havana Paving and Sewerage Contract, Havana, Cuba		April 4, 1906
Hyde, John Lawrence. Asst. Town Engr., Westfield, Mass		July 10, 1907
Hyde, William Herbert. Contr., 170 Lincoln Ave., Bellevue, Pa	Jun. Assoc. M.	April 30, 1901 June 4, 1902
Ichinose, Kyojiro. Dobokukyoku, Naimusho, Tokyo, Japan		Jan. 8, 1908
Ijams, Jesse Warren. Mech. Engr., Gen. Purchasing Dept., N. Y. C. Lines, 312 Grand Central Station, New York City		April 6, 1909

		Date of Membership.
Ilsley, Arthur Benjamin. Bridge Engr., Southern Ry., 1300 Penn. Ave., Washington, D. C.	Jun. Assoc. M.	Feb. 28, 1899 Mar. 4, 1903
Immediato, Gerardo. 53 N. Willow St., Montclair, N. J....		July 9, 1906
Inagaki, Hyotaro. Res. Engr., Imperial Govt. Ry., Ikegami-mura, Ebaragori, Tokyo, Japan......................		Oct. 2, 1907
Ingersoll, Charles Anthony. Res. Engr., N. Y. State Barge Canal, Medina, N. Y................................		Nov. 7, 1906
Ingram, Edward Lovering. Asst. Prof. of R. R. Eng. and Geodesy, Univ. of Pennsylvania (Res., 3643 Locust St.), Philadelphia, Pa............................		Sept. 4, 1895
Ingram, Willard Edward. Chf. Structural Engr., The Arnold Co., 181 La Salle St., Chicago, Ill...............		Oct. 2, 1907
Innes, Harry Clifford. Cons. and Const. Civ. Engr., Station R, Cincinnati, Ohio................................		Feb. 6, 1907
Irish, Leland Wesley. Asst. Prof. of Civ. Eng., Coll. of Eng., Northwestern Univ.; Address, 808 Hamlin St., Evanston, Ill...............	Jun. Assoc. M.	Feb. 4, 1908 Feb. 1, 1910
Jackson, Granbery. Chf. Engr., International Agri. Corp., 116 Twenty-first Ave., South, Nashville, Tenn...........		Jan. 4, 1905
Jackson, James Madison. Pres. and Gen. Mgr., Everglade Cypress Lumber Co., Parkersburg, W.-Va.................		Jan. 2, 1901
Jackson, John Franklin. Contr. Engr., Wisconsin Bridge & Iron Co., 605 Colby-Abbot Bldg., Milwaukee, Wis........		May 2, 1894
Jacobs, Robert Hyde. Asst. Engr., Public Service Comm., 252 West 139th St., New York City......................		May 4, 1904
Jahncke, Ernest Lee. Mgr., The Jahncke Nav. Co., New Orleans, La..		July 10, 1907
James, Alfred Randolph. Junior Engr., Pac. Div., Isthmian Canal Comm., Corozal, Canal Zone, Panama...........		Nov. 8, 1909
Janney, Thomas Gordon. Gen. Mgr., The Shasta Dredging Co., Larkin, Cal....................................		Oct. 3, 1900
Jansen, Edward Clinton. Care, Central Colorado Power Co., 1210 Seventeenth St., Denver, Colo..................		May 3, 1905
Janvrin, Ned Herbert. Asst. Engr., Board of Water Supply, City of New York, R. F. D. No. 4, Newburgh, N. Y.....................	Jun. Assoc. M.	Oct. 5, 1897 June 5, 1901
Jenckes, Lawrence Bates. 46 Fruit St., Worcester, Mass............................	Jun. Assoc. M.	Mar. 31, 1891 Oct. 7, 1896
Jenkins, James Edgar. Engr. in Chg. of Contract No. 9, Erie Canal, for Thomas Crimmins Contr. Co., Box 73, Medina, N. Y....................................		Dec. 5, 1906
Jewel, Lindsey Louin. Mgr. of Erection, McClintic-Marshall Constr. Co., Pittsburg, Pa............................		April 4, 1906
Jewett, Thomas Edward. Vice-Pres., H. L. Stevens & Co., 802 Texas Ave., Houston, Tex......................		Nov. 30, 1909

	Date of Membership.
JOHANNESSON, SIGVALD. 9 Garden St., Montclair, N. J.	Nov. 1, 1905
JOHNSON, ALEXANDER. Cons. Engr., Dept. of Bridges, 13 Park Row, New York City	Sept. 5, 1900
JOHNSON, EDWIN SAMUEL. 411 Keystone Bank Bldg., Pittsburg, Pa.	Oct. 2, 1907
JOHNSON, GEORGE ARTHUR. (Hering & Fuller, Cons. Engrs.), 170 Broadway, New York City	Feb. 6, 1907
JOHNSON, GEORGE RUFUS. 700 Washington Ave., West Haven, Conn.	May 1, 1907
JOHNSON, MARO. Asst. Engr., Ill. Cent. R. R., 6549 Minerva Ave., Chicago, Ill.	April 6, 1909
JOHNSON, RANKIN. Care, Burges Johnson, Port Washington, N. Y.	Feb. 7, 1900
JOHNSON, WILLIAM EDWARD. Chf. Engr., for Hartford Water Comm., P. O. Box 37, West Hartford, Conn.	April 3, 1901
JOHNSTON, CHARLES EUGENE. Div. Engr., Kansas City Southern Ry., Mena, Ark.	June 1, 1909
JOHNSTON, JOHN PARRY. Gen. Sales Mgr., The New York Engine Co., 165 Broadway, New York City	Assoc. April 3, 1894 Assoc. M. Nov. 1, 1904
JOHNSTON, JULIUS GERARDUS. 408 Moore-Burnette Bldg., Houston, Tex.	Feb. 6, 1907
JOHNSTONE, WILLIAM BARD. Cons. Engr., 1123 Broadway, New York City	May 4, 1904
JONES, FREDERICK ARMISTEAD. Asst. Engr., Mo. Pac. Ry. Co., 7th and Poplar Sts., St. Louis, Mo.	Nov. 8, 1909
JONES, HENRY LLEWELLYN. Res. Engr., U. S. Steel Products Export Co., 30 Church St., New York City	Oct. 5, 1898
JONES, SAMUEL REYNOLDS. Structural Engr., J. G. White & Co., 43 Exchange Pl., New York City	April 6, 1909
JONES, SIDNEY GARDNER. Asst. to Chf. Engr., M., St. P. & S. Ste. M. Ry., Soo Line, Gen. Offices (Res., 122 West Grant St.), Minneapolis, Minn.	Jan. 2, 1907
JONES, THOMAS JOHN. 95 Bellevue Ave., San Mateo, Cal.	June 1, 1904
JONES, WALTER ALPHEUS. Chf. Engr., Titusville Northern R. R., Box 270, Titusville, Pa.	Nov. 30, 1909
JONSON, ERNST FREDRIK. Engr. Insp., Board of Water Supply, 299 Broadway, New York City	Jan. 3, 1900
JORDAHL, ANDERS. Care, Deutsche Kahneisen Gesellschaft, 77 Charlotten Strasse, Berlin, Germany	Nov. 6, 1907
JORDAN, WILLIAM FREDERICK. Mgr., Grand Central Terminal Impvts., 124 Fisher Ave., White Plains, N. Y.	April 1, 1891
JORGENSEN, LARS RASMUS. Designing Engr., F. G. Baum & Co. 1406 Chronicle Bldg., San Francisco, Cal.	May 4, 1909
JOUETT, HENRY DETRICK. Designing Engr., N. Y. C. & H. R. R. R., 335 Madison Ave., New York City	Feb. 7, 1906

		Date of Membership.
JUBB, SHERMAN AUGUSTUS. Cons. Engr., 301 Kohl Bldg., San Francisco, Cal.		Mar. 6, 1907
JUDD, FRANK RHYMAL. Chf. Draftsman, Bridge Dept., Ill. Cent. R. R., Chicago, Ill.		Mar. 2, 1909
JUDELL, ADOLPH. 20 Front St., San Francisco, Cal.		April 4, 1906
KABASHIMA, MASAYOSHI. Eng. Dept., City Hall, Tokyo, Japan.		May 2, 1906
KAFKA, FREDERICK PERCEVAL. Pres., Herringbone Metal Lath Co., 257 East 133d St., New York City.		May 1, 1907
KAHN, JULIUS. Pres., Trussed Concrete Steel Co.; Gen. Mgr., Concrete Steel & Tile Constr. Co., Detroit, Mich.	Jun. Assoc. M.	May 3, 1898 Oct. 3, 1900
KAST, CLARKE NIGHTINGALE. Bureau of Public Works, Manila, Philippine Islands.	Jun. Assoc. M.	June 4, 1901 June 7, 1905
KASTENHUBER, EDWIN GUSTAV, JR. P. O. Box 677, Bordentown, N. J.		July 1, 1909
KAUFFMAN, VERNET ALBERT. 1931 Broadway, Denver, Colo.	Jun. Assoc. M.	Feb. 3, 1903 July 10, 1907
KAWAGUCHI, TORAO. Koto Kogyogakko (Higher School of Technology), Kumamoto, Japan.		Oct. 4, 1905
KEAYS, REGINALD HORTON. Care, Degnon Contr. Co., New Paltz, N. Y.	Jun. Assoc. M.	June 6, 1899 April 3, 1901
KEIM, WARREN BYRON. Asst. Engr., Bridge and Constr. Dept., The Pennsylvania Steel Co., Steelton, Pa.; Address, 129 N. 4th St., Harrisburg, Pa.		Jan. 4, 1905
KEITH, CHARLES WHITESIDE. Bridge Engr., Bureau of Public Works, Manila, Philippine Islands.		Mar. 7, 1906
KEITH, LORIN ACIL. Mansfield, Ohio.		Oct. 2, 1907
KELLEY, MATTHEW DETOBIN. Cons. Engr., Lander, Wyo.	Jun. Assoc. M.	Sept. 3, 1907 June 1, 1909
KELLOGG, ALBERT VICTOR. Engr., M. of W., Morgan's Louisiana & Texas R. R. & S. S. Co., Louisiana Western R. R. Co., Texas & New Orleans R. R. Co., Galveston, Harrisburg & San Antonio Ry. Co., Houston, Tex.		Nov. 6, 1895
KELLY, WILLIAM. Capt., Corps of Engrs., U. S. A., District Bldg., Washington, D. C.		Feb. 3, 1904
KEMP, JOHN EDWARD. Civ. Engr., Kewanee Works, National Tube Co., Kewanee, Ill.		April 1, 1908
KEYS, EDWARD ALLEN. Civ. Engr. and Supt. of Const., Walter Reed U. S. Army General Hospital, Takoma Sub-Station, Washington, D. C.		July 9, 1906
KIEHM, CHARLES. 196 Central Ave., Albany, N. Y.		Jan. 8, 1908
KILLAM, CHARLES WILSON. Asst. Prof. of Architectural Constr., Harvard Univ., 20 Walker St., Cambridge, Mass.		Dec. 4, 1907
KIMBALL, WILLIAM HALE. 202 Bridge Ave., Davenport, Iowa.		April 1, 1903

		Date of Membership.
KING, CLIFFORD MARSHALL. City Engr., Sandusky, Ohio	Jun. Assoc. M.	Mar. 6, 1906 July 1, 1909
KING, EVERETT EDGAR. Associate Prof. of Civ. Eng., A. & M. Coll. of Oklahoma, Stillwater, Okla		Nov. 7, 1906
KING, ROY STEVENSON. Mech. Engr., 43 Wroe Ave., Dayton, Ohio		Jan. 4, 1910
KINNE, GEORGE WHITNEY. Erecting Dept., Am. Bridge Co. of N. Y., Room 209, Fuller Bldg., Jersey City, N. J		Dec. 5, 1906
KIRBY, ISAAC HENRY. Roslyn, Nassau Co., N. Y		Nov. 1, 1905
KIRCHNER, PAUL ALOIS. 40 West 36th St., New York City		Sept. 6, 1905
KIRKHAM, JOHN EDWARD. Associate Prof. in Civ. Eng., Iowa State Coll., Ames, Iowa		Feb. 7, 1906
KIRKPATRICK, HARLOW BARTON. Bureau of Public Works, Manila, Philippine Islands		Mar. 2, 1909
KISSACK, ALFRED BROUGHTON. Civ. Engr and Contr. (Kissack & Cavanagh), Hinton Theatre Bldg., Muskogee, Okla.		May 4, 1909
KLEINSCHMIDT, HENRY SCHWING. P. O. Box 873, Salt Lake City, Utah	Jun. Assoc. M.	Mar. 1, 1904 Dec. 1, 1908
KLOSSOWSKI, THEODORE JULIUS. Orofino, Idaho		April 6, 1904
KNAP, EDGAR DAY. Asst. Engr., Dept. of Bridges, 179 Washington St., Brooklyn, N. Y	Jun. Assoc. M.	Dec. 1, 1896 Dec. 4, 1900
KNIGHT, EARLE KELLY. Room 532, Candler Bldg., Atlanta, Ga.		Dec. 4, 1907
KNIGHT, FRANK BARR. Chicago Mgr. and Engr., Lidgerwood Mfg. Co., 1917 Fisher Bldg., Chicago, Ill		Sept. 4, 1901
KNOCH, JULIUS JAMES. Prof. of Civ. Eng., Univ. of Arkansas, Fayetteville, Ark		Oct. 2, 1901
KOCH, JOHN CHRISTIAN. 740 West 26th St., Chicago, Ill		Jan. 4, 1910
KOENIG, ARNOLD CHARLES. Cons. and Contr. Engr., 616 Bee Bldg., Omaha, Nebr		Nov. 7, 1900
KOLB, HENRY JACOB. Asst. Engr., Brooklyn Rapid Transit System, 85 Clinton St., Brooklyn, N. Y	Jun. Assoc. M.	Feb. 3, 1903 April 4, 1906
KOON, RAY EMERSON. Associate with Burns & McDonnell, Civ., Hydr. and San. Engrs., 823 Scarritt Bldg., Kansas City, Mo		Oct. 7, 1908
KREINER, HARRY PETER. Surv. and Mun. Engr. (Borrie & Kreiner), 788 Broad St., Newark, N. J		Jan. 8, 1908
C. KRELLWITZ, DIEDRICH WILLIAM. 423 Thirteenth St., West New York, N. J	Jun. Assoc. M.	Oct. 31, 1905 Feb. 2, 1909
KREUGER, IVAR. Contr. (Kreuger & Toll), Vasagatan 15, Stockholm, Sweden		Dec. 7, 1904
KYLE, GEORGE ALLEN. Chf. Engr., Oregon Trunk Ry., The Dalles, Ore		Feb. 2, 1892
LAFLER, WILLIAM ARTHUR. Asst. Engr., Dept. of State Engr., P. O. Box 351, Whitesboro, N. Y		May 4, 1909

		Date of Membership.
Lamb, Ernest Avery. Res. Engr., Barge Canal Dredging Contracts, Sections Nos. 2 and 3, Res. Engr.'s Office, Guy Park House, Amsterdam, N. Y.		Sept. 7, 1904
Lambert, Byron James. Prof. of Structural Eng., State Univ. of Iowa, Iowa City, Iowa		Jan. 5, 1909
Lambert, Wallace Corliss. Gleasondale, Mass		April 4, 1900
Lambie, Charles Sumner. Pres., The C. S. Lambie Co., Engrs. and Contrs., Wabash Bldg., Pittsburg, Pa	Jun.	Oct. 1, 1901
	Assoc. M.	Feb. 6, 1907
Lamont, Clarence Booth. Asst. to Pres., The Moran Co. (Res., 1103 Cherry St.), Seattle, Wash		May 4, 1909
Lanagan, Frank Ray. Deputy City Engr. (Res., 273 Hamilton St.), Albany, N. Y.	Jun.	Sept. 5, 1905
	Assoc. M.	Feb. 1, 1910
Lancashire, Forest Henry. Designing and Const. Engr., 842 Wilson Bldg., Dallas, Tex		July 10, 1907
Landers, Charles Scott. Care, Hildreth & Co., 135 Broadway, New York City		April 1, 1908
Lane, Edward Percy. Asst. Engr., N. Y. C. & H. R. R. R., 335 Madison Ave., Room 1221, New York City		Jan. 5, 1909
Lane, Edwin Grant. Engr., M. of W., Pittsburg System, B. & O. R. R., B. & O. Depot, Pittsburg, Pa		Jan. 8, 1902
Lane, Harry Alfred. Asst. Engr., M. of W., B. & O. R. R., B. & O. Bldg., Baltimore, Md		Feb. 1, 1905
Lange, Theodore Ferdinand. Asst. Engr., N. Y. C. & H. R. R. R. Co., 122 West 90th St., New York City		Feb. 5, 1908
Lannan, Louis Edgar. Locating Engr., W. & N. R. R., Savoy Apartments, Coal and Rebecca Sts., Wilkinsburg, Pa		June 7, 1905
Larmon, Frank Perry. Supt., The Lovejoy Co., Cambridge, N. Y.		July 9, 1906
Larrison, George Kirkpatrick. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands		July 1, 1908
Larson, Clarence Melrose. Real Estate Engr., Clover-Leaf, Alton, M. & St. L. Lines, 900 Railway Exchange, Chicago, Ill		Oct. 7, 1908
LaRue, Eugene Clyde. Dist. Engr., Water Resources Branch, U. S. Geological Survey, Box 972, Salt Lake City, Utah.		Jan. 4, 1910
Lasley, Charles Orton. Engr., The A. Bentley & Sons Co., Gen. Contrs., Toledo, Ohio		May 4, 1904
Lathrop, Jay Cowden. Supt. of Constr., Am. Railways Co., Dayton, Ohio		Oct. 2, 1907
Laurgaard, Olaf. Asst. Engr., U. S. Reclamation Service, Conconully, Wash		June 1, 1909
Lavelle, Thomas Monahan. Engr. with The Eastern Steel Co., Pottsville, Pa		Sept. 7, 1904

		Date of Membership
Lawrence, Charles Walter. Prof., Civ. Eng., Univ. of Southern California, 1203 W. 36th Pl., Los Angeles, Cal		Jan. 8, 190
Lawson, Lawrence Milton. Asst. Engr., U. S. Reclamation Service, Yuma, Ariz		Oct. 3, 190
Lawton, Perry. 7 Savings Bank Bldg., Quincy, Mass	Jun. Assoc. M.	Jan. 3, 189 Sept. 2, 189
Lawton, Walter Luman. 85 West Cayuga St., Oswego, N. Y.		Mar. 5, 190
Leahy, Maurice Joseph. South Hadley Falls, Mass		Dec. 4, 190
Leake, Boudinot Gage. Civ. Engr. and Archt., Room 28, Dundee Bldg., Fort Worth, Tex	Jun. Assoc. M.	Jan. 5, 190 May 3, 190
Leane, Walter Burditt. Civil Service Club, Capetown, South Africa		Jan. 3, 190
Lee, Augustine Leftwich. Asst. Engr., Am. Bridge Co., Ambridge, Pa		Oct. 3, 190
Lee, David Read. Care, Div. Engr., N. Y. State Canals, State Hall, Albany, N. Y		Oct. 7, 189
Lee, Elsworth Mortimer. (Lee & Hewitt, Engrs. and Archts.), 1123 Broadway, New York City		Mar. 7, 190
Lee, Engbert A. Asst. Engr., Am. Smelting & Refining Co., Symes Bldg., Denver, Colo		Oct. 7, 190
Lee, George William. Chf. Engr., Sundstrom & Stratton, New York City; Address, Canaseraga, N. Y	Jun. Assoc. M.	Mar. 4, 190 Jan. 2, 190
Lee, John Louis. 76 Beekman Ave., Mt. Vernon, N. Y		April 3, 190
Leefe, Frederick Ewbank. U. S. Junior Engr., Local Chg., Constr., Dalles Celilo Canal, U. S. Engr. Office, Celilo, Ore		May 6, 190
Leeper, John Bigger. Asst. Engr., Am. Bridge Co., Frick Bldg., Pittsburg, Pa		Jan. 3, 190
Leffler, Burton Rutherford. Engr. of Bridges, L. S. & M. S. Ry., 4409 Franklin Ave., Cleveland, Ohio		April 6, 190
Leighton, Marshall Ora. Chf. Hydrographer, U. S. Geological Survey (Res., 1759 Lanier Pl.), Washington, D. C		Oct. 4, 190
Leland, Ora Miner. Asst. Prof. of Astronomy and Geodesy, Cornell Univ., Cascadilla Bldg., Ithaca, N. Y		Feb. 1, 190
Lemen, William Caswell Smith. Junior Engr., U. S. Engr. Office, Brunswick, Ga		July 10, 190
Leonard, Clifford Milton. Pres. and Treas. of the Leonard Constr. Co., Monadnock Blk., Chicago, Ill		Oct. 2, 190
Letson, Thomas Herbert. 39 Cortlandt St., New York City	Assoc. Assoc. M.	Mar. 1, 190 Oct. 2, 190
Lewis, Arthur Stephen. Asst. Secy. and Supt., Lincoln Park System, Chicago, Ill		April 6, 190
Lewis, Clarence McKenzie. Care, Wm. Salomon & Co., 25 Broad St., New York City		Dec. 3, 1902

		Date of Membership.
Lewis, Clifford, Jr. Second National Bank Bldg., Utica, N. Y.		Sept. 2, 1903
Lewis, John Howard. State Engr., Salem, Ore		Sept. 6, 1905
Lewis, Luther Hammond. Archt., 160 Fifth Ave., New York City		April 6, 1904
Lewis, Ransome Tedrowe. Mgr., Elmira Plant, Empire Bridge Co., Elmira, N. Y		June 6, 1906
Lewis, Walter Raleigh. Supt., Trinidad Water-Works, 3 Colorado Bldg., Trinidad, Colo		May 3, 1905
Lex, Washington Irving. 1508 N. 19th St., Philadelphia, Pa.		May 2, 1906
Lightfoot, William Joseph. U. S. Examiner of Surveys, 615 Leavenworth St., Manhattan, Kans		Feb. 1, 1905
Linard, Drew Jones. Care, American Consulate, Ceiba, Honduras		July 10, 1907
Lindau, Alfred Emanuel. Company Engr., Expanded Metal & Corrugated Bar Co., St. Louis, Mo		Jan. 3, 1906
Lindhé, John Birger. Jun. Civ. Engr., U. S. Engr. Dept., Burrwood, La		Nov. 4, 1908
Lindholm, Carl Bertram. (Lindholm & Tuller), Agri. National Bank Bldg., Pittsfield, Mass		April 6, 1909
Lindsey, Kieffer. Crystal Springs, Ga	Jun.	Oct. 7, 1902
	Assoc. M.	Oct. 4, 1905
Lineberger, Walter Franklin. (Lineberger & Rone), Apartado No. 333, Torreón, Coahuila, Mexico		May 4, 1909
Linnell, Herbert Prescott. Chf. Engr., Atlantic, Gulf & Pacific Co., Manila, Philippine Islands		May 2, 1906
Little, George Kerr. U. S. Asst. Engr., Tuscaloosa, Ala		June 3, 1903
Livermore, Norman Banks. Pres., Norman B. Livermore & Co., Metropolis Bank Bldg., San Francisco, Cal	Jun.	Dec. 5, 1899
	Assoc. M.	Oct. 1, 1902
Lobo, Carlos. Asst. Engr., Dept. of Water Supply, Municipal Bldg. (Res., 550 Seventh St.), Brooklyn, N. Y.		May 3, 1905
Lochridge, Elbert Emerson. Chf. Engr., Water Dept., 43 Bridge St., Springfield, Mass		May 3, 1905
Locke, William Willard. San. Insp., Met. Water and Sewerage Board, 5 Myrtle St., South Framingham, Mass		Oct. 6, 1897
Loewenstein, Jacob. Am. Bridge Co., 30 Church St. (Res., 2 West 94th St.), New York City		Feb. 6, 1907
Logan, William Seeley. City Surv., 121 Midland Ave., Arlington, N. J		April 6, 1904
Lombardo, Javier Diaz. Chf. Engr., "Empresa Hidro-Eléctrica de Apulco," Apulco (*via* Tulancingo), Hidalgo, Mexico.		Oct. 2, 1907
Long, Clarence Burton. Asst. Engr., U. S. Reclamation Service, Augusta, Mont		Nov. 8, 1909
Long, Eugene McLean. (Long & Miller, Cons. Engrs.), 220 Broadway, New York City		June 1, 1898

		Date of Membership.
LONG, JOHN COLEMAN. Long Constr. Co., 106 R. A. Long Bldg. (Res., 3415 Summit St.), Kansas City, Mo		Jan. 8, 1908
LONGLEY, FRANCIS FIELDING. Res. Engr., Toronto Filtration Plant, Toronto, Ont., Canada	Jun. Assoc. M.	Feb. 28, 1905 Mar. 2, 1909
LORENZ, GEORGE BENJAMIN. Asst. Engr. with George N. Randle, City Engr., 1826 G St., Sacramento, Cal		Jan. 4, 1910
LOUWERSE, PETER MARTIN. Trussed Concrete Steel Co., 145 Euclid Ave. West, Detroit, Mich		April 1, 1908
LOVE, ANDREW CAVITT. Constr. Engr., Beaumont Irrigating Co., Beaumont, Tex		Feb. 6, 1907
LOVELL, EARL BRINK. Prof., Civ. Eng., Columbia Univ.; Vice-Pres., Chas. Hansel & Co.; Mgr. of Eng. Dept., Lawyers Title Insurance & Trust Co., New York City		April 4, 1906
LOVETT, GEORGE FREDERICK. City Engr., Berlin, N. H		Sept. 7, 1904
LOW, GEORGE EVARTS. 45 Broadway, New York City	Jun. Assoc. M.	Nov. 6, 1894 Mar. 2, 1898
LOWINSON, OSCAR. Cons. Archt. and Engr., 18 East 42d St., New York City	Jun. Assoc. M.	May 3, 1892 Feb. 7, 1900
LOWTHER, BURTON. Const. Engr., Water-Works Dept., 2608 Brooklyn Ave., Kansas City, Mo		Oct. 7, 1908
LUCAS, GEORGE LATIMORE. Asst. Engr., Public Service Comm., 154 Nassau St., New York City		Dec. 7, 1904
LUDWIG, JULIUS ALFRED. 79 Wall St., New York City	Jun. Assoc. M.	May 31, 1892 Oct. 2, 1895
LUND, GEORGE ALFRED. Mgr., Post & McCord, 44 East 23d St., New York City		Nov. 7, 1894
LUND, ROBERT LEATHAN. Cons. Engr., 5968 W. Cabanne Pl., St. Louis, Mo		May 4, 1904
LUNDOFF, CLEMENS WALDEMAR. Vice-Pres., Crowell & Sherman Co., 3111 Carnegie Ave., Cleveland, Ohio		June 3, 1908
LYLE, WILLIAM THOMAS. Asst. Prof. of Municipal Eng. and Insp. of Bldgs., Lafayette Coll., Easton, Pa		Nov. 6, 1901
LYMAN, RICHARD ROSWELL. Cons. Engr.; Prof. of Civ. Eng., 34 Engineering Bldg., Univ. of Utah, Salt Lake City, Utah	Assoc. Assoc. M.	May 4, 1904 Feb. 2, 1909
LYNCH, TILLMAN DANIS. Engr. in Chg. of Processes, Westinghouse Elec. & Mfg. Co., East Pittsburg Works; Address, 816 Wallace Ave., Wilkinsburg Sta., Pittsburg, Pa		Nov. 3, 1897
LYON, WALLACE CHITTENDON. Asst. Structural Engr., Care, Superv. Archt.'s Office, Washington, D. C		Feb. 6, 1901
LYTEL, JAMES LEONARD. Project Engr., Strawberry Val. Project, U. S. Reclamation Service, Provo, Utah		Jan. 4, 1905
MACARTNEY, MORTON. Care, North Coast R. R. Co., 918 Paulsen Bldg., Spokane, Wash		Mar. 2, 1909

		Date of Membership.
MacCracken, George Gere. Gen. Mgr., MacCracken-Hauer-Terry Co., 13 Park Row, New York City	Jun. Assoc. M.	Feb. 5, 1901 Feb. 3, 1904
MacCrea, Don Alexander. Cons. Engr. (Ford & MacCrea), Room 338, Gazette Bldg., Little Rock, Ark	Jun. Assoc. M.	May 2, 1899 Oct. 1, 1902
MacDiarmid, Milo Stuart. Junior Engr., U. S. Lake Survey, 205 Old Custom House, Detroit, Mich		Sept. 4, 1907
Macdonald, Archibald Angus. Archt., 550 West 41st St., New York City	Jun. Assoc. M.	June 4, 1901 Oct. 5, 1904
MacGregor, John Grant. Chf. Engr., Alberta Central Ry., Red Deer, Alta., Canada		June 3, 1903
MacGregor, Robert Athole. Asst. Engr., Bureau of Highways, Borough of the Bronx (Res., 2428 Lorillard Pl.), New York City		Nov. 2, 1898
Mack, Edward R. Supt. of Parks, 806 Van Buren St., Wilmington, Del		June 7, 1905
Mackenzie, George Riddick. Civ. and Min. Engr., 1341 Arch St., Philadelphia, Pa		June 6, 1906
Maclay, Edgar Gleim. Chf. Engr., The Am. Constr. Co., Houston, Tex		Oct. 3, 1906
Macnab, George Travilla. Asst. Engr., Highways, Borough of the Bronx, 106 West 130th St., New York City		Feb. 3, 1897
MacNair, Henry James. Compiler, Official Automobile Blue Book, 1200 Michigan Ave., Chicago, Ill		June 1, 1904
MacNaughton, Ernest Boyd. 606 Concord Bldg., Portland, Ore		Oct. 7, 1908
MacNeille, Perry Robinson. Cons. Engr., 12 East 45th St., New York City	Jun. Assoc. M.	April 5, 1898 June 5, 1901
Macomb, John de Navarre, Jr. 1033 Railway Exchange, Chicago, Ill		Oct. 5, 1904
Macy, Elbert Clyde. Supt. of Constr., Stone & Webster Engr. Corp., 419 White Bldg., Seattle, Wash		Sept. 2, 1903
McBee, Vardry Echols, Jr. Locating Engr., S. A. L. Ry., Care, Chf. Engr., Portsmouth, Va		Oct. 7, 1908
McClelland, Claude Leslie. Asst. Engr., New York State Barge Canal, Waterford, N. Y		Oct. 7, 1908
McClure, John Clarendon. Engr., M. of W., Cananea, Yaqui River & Pacific R. R., Sonora Ry. and S. P. Co., Branch Lines in Arizona, Tucson, Ariz		Feb. 6, 1895
McConnell, Ira Welch. Chf. Irrig. Engr., J. G. White & Co., Inc., Richfield, Idaho		Dec. 7, 1904
McConnell, John Lorenzo. 5463 Jefferson Ave., Chicago, Ill	Jun. Assoc. M.	April 4, 1905 Jan. 2, 1907
McCord, James Benney. 1 Broadway, New York City		Jan. 2, 1907

		Date of Membership.
McCormick, Herbert Granville. With U. S. Govt., Lock and Dam Constr., Kentucky River, Thirteen, Ky.		April 1, 1908
McCornack, Clyde Webster. Asst. Engr., Phœnix Bridge Co., 413 Gay St., Phœnixville, Pa.	Jun. Assoc. M.	Jan. 31, 1905 Dec. 1, 1908
McCoy, Charles Ephraim. Fraziers Bottom, Putnam Co., W. Va.		June 3, 1903
McCulloch, Richard. Asst. Gen. Mgr., United Rys. Co. of St. Louis, 3869 Park Ave., St. Louis, Mo.		Mar. 2, 1898
McCurdy, Harry Sherwood Royden. Div. Engr., Board of Water Supply of the City of New York, Brown Station, N. Y.		Sept. 7, 1904
McDaniel, Allen Boyer. Prof. of Civ. Eng., Univ. of South Dakota; Cons. Engr. and Archt., Vermilion, S. Dak.		Nov. 1, 1905
McDargh, Harry John. 806 A Ave., Lawton, Okla.		April 2, 1902
McDonough, James Albert. Junior Engr., U. S. Engr. Office, Wheeling, W. Va.		April 3, 1907
McDonough, Michael Joseph. Capt., Corps of Engrs., U. S. A., Washington Barracks, D. C.		Jan. 2, 1907
McGeehan, Paul. 4323 Charlotte St., Kansas City, Mo.		July 10, 1907
McGonigle, Charles Joseph. Asst. Contr. Agt., Milliken Bros., Inc., 607 Humboldt Bank, San Francisco, Cal.		May 6, 1908
McGregor, Robert Roy. Div. Engr., Compania Constructora Richardson, S. A., Esperanza, Sonora, Mexico		Mar. 6, 1907
McHarg, Leslie. Contr., 165 Broadway, New York City	Jun. Assoc. M.	Mar. 5, 1901 April 6, 1909
McKenzie, Thomas. Westerly, R. I.	Jun. Assoc. M.	May 2, 1893 Nov. 6, 1895
McLean, Joseph Patton. 68 Garrison Ave., Jersey City, N. J.		Mar. 2, 1904
McLure, Norman Roosevelt. Care, Phœnix Iron Co., Phœnixville, Pa.	Jun. Assoc. M.	Feb, 6, 1906 Nov. 4, 1908
McMeekin, Charles William. Gen. Mgr., Crœsus Gold Min. & Milling Co., Plumbago, Alleghany P. O., Sierra Co., Cal.	Jun. Assoc. M.	April 2, 1890 Mar. 7, 1894
McMorrow, James Walter. Secy., McMorrow Eng. & Constr. Co., 360 West 125th St. (Res., 551 West 170th St.), New York City		Oct. 7, 1908
McPherson, Robert Henry. Mech. Engr., 1275 Old Colony Bldg., Chicago, Ill.		Jan. 4, 1905
Madden, John Henry. Asst. Engr., Public Service Comm. for the First Dist., 308 West 30th St., New York City	Jun. Assoc. M.	Oct. 7, 1902 May 4, 1904
Magor, Henry Basil. Pres., Wonham Magor Car & Mfg. Co., 30 Church St., New York City.	Jun. Assoc. M.	April 30, 1895 Mar. 7, 1900
Maier, Harry Ludwig. Asst. Engr., Street and Sewer Dept., 229 Connell St., Wilmington, Del.		June 5, 1907

		Date of Membership.
Mair, John William. 100 West Lincoln Ave., Mt. Vernon, N. Y.		April 1, 1908
Malcolm, Charles Wesley. Asst. Prof. of Structural Eng., Univ. of Illinois, 908 W. Nevada St., Urbana, Ill.	Jun. Assoc. M.	Sept. 4, 1906 April 6, 1909
Malukoff, Alexis Joseph. Asst. Engr., Dept. of Bridges (Res., 213 West 136th St.), New York City		Jan. 2, 1901
Manchester, Ernest. Moreland, Melbourne, Australia		May 3, 1905
Mann, John Laroy. Ingeniero del Gobierno, Dept. of Public Works, Santo Domingo, Santo Domingo	Jun. Assoc. Assoc. M.	April 2, 1901 May 6, 1902 Sept. 1, 1908
Manning, William Sheppard, Jr. The Solvay Process Co., Syracuse, N. Y.		Sept. 6, 1905
Mansfield, Royal John. 49 Claremont Ave., New York City	Jun. Assoc. M.	Dec. 2, 1902 July 10, 1907
Manter, Ralph Barton. Locating Engr., Ferrocarril del Cauca, Cali, Colombia		June 1, 1904
Mapes, Charles Maynard. Smith Bldg., 148th St. and Third Ave., New York City		July 10, 1907
Markwart, Arthur Hermann. (Galloway & Markwart), First National Bank Bldg., San Francisco, Cal.		July 9, 1906
Marquand, Philip. Allen, Sand & Co., Bankers, 44 Pine St., New York City		Oct. 5, 1898
Marshall, Cyril Ernest Davis. Garden City, N. Y.		Mar. 6, 1907
Marshall, Thomas Clawson. Engr. and Contr. (Marshall & Loughborough), Goshen, N. Y.		May 4, 1909
Marshall, Thomas Worth. (Marshall & Marshall), 729 Fifteenth St., N. W., Washington, D. C.		June 3, 1908
Martin, Bertrand Clifford. Asst. Dist. Engr., N. Y. C. & H. R. R. R. Co., 163 Flower Ave., East, Watertown, N. Y.		May 4, 1909
Martin, James William. U. S. Indian Service, 522 Bumiller Bldg., Los Angeles, Cal.		Nov. 1, 1899
Martin, Walter Irving. 5212 South Park Ave., Chicago, Ill.		April 1, 1908
Martinez y Reugifo, Conrado Eugenio. 168 San Miguel St., Havana, Cuba		Oct. 7, 1908
Mason, Samuel Jefferson. City Surv.; (Mason & Smith), 102 Smith St., Perth Amboy, N. J.		Jan. 8, 1908
Massenburg, Walter Gray. Div. Engr., G. C. & S. F. Ry., Beaumont, Tex.		Jan. 2, 1907
Matheson, Ernest George. 521 West 124th St., New York City.		June 1, 1904
Matheson, John Douglas. Representative, Warren & Wetmore, Archts., New Union Terminal, Winnipeg, Man., Canada	Jun. Assoc. M.	Mar. 3, 1903 May 1, 1907
Matlaw, Isaac Solon. Asst. Engr., Dept. of State Engr. and Surv., Vischer Ferry, N. Y.	Jun. Assoc. M.	Oct. 2, 1906 July 1, 1909
Matson, Jesse Sidwell. County Engr., Jefferson, Ohio		July 1, 1908

		Date of Membership.
MATTHES, FRANCOIS EMILE. Topographic Insp., U. S. Geological Survey, Washington, D. C.		April 3, 1901
MAUGHMER, CARL. 2616 N St., Sacramento, Cal.		Jan. 4, 1910
MAUPIN, EDGAR STAPLES. 1200 Grove St., Vicksburg, Miss.	Jun. Assoc. M.	Sept. 5, 1905 Nov. 8, 1909
MAYHEW, ALFRED BOARDMAN. Asst. Engr., U. S. Reclamation Service, Boise, Idaho		Nov. 8, 1909
MEADOWCROFT, WILLIAM. Asst. Engr. (Designer), Board of Water Supply, 299 Broadway, New York City		Dec. 6, 1905
MEEK, GORDON STAFFORD. Dock Supt., Penn. & Lake Erie Dock Co., Fairport Harbor (Res., Painesville), Ohio		Oct. 4, 1905
MEGGY, ROBERT LOUIS GURDELSTON. North Ave. and Russell Rd., Fanwood, N. J.		Feb. 6, 1907
MEIER, WILLIAM. Bridge Dept., C. & N. W. Ry., 2152 Alice Pl., Chicago, Ill.		June 1, 1909
MELICK, NEAL ALBERT. Supt. of Constr., U. S. Public Bldgs., Moline, Ill.	Jun. Assoc. M.	Dec. 2, 1902 July 9, 1906
MELIUS, LUDLOW LAWRENCE. Care, Spuyten Duyvil Constr. Co., 271 West 125th St., New York City	Jun. Assoc. M.	May 2, 1899 Dec. 6, 1905
MELLUISH, JAMES GEORGE. Civ. and San. Engr., 222 Unity Bldg., Bloomington, Ill.		June 7, 1905
MERRICK, HOWARD B. 928 Church St., Ann Arbor, Mich.		July 1, 1909
MERRILL, OGDEN. Pres., Merrill-Ruckgaber Co., 50 Church St., New York City		Feb. 3, 1904
MERRILL, OSCAR CHARLES. Dist. Engr., Dist. 5, U. S. Forest Service, San Francisco, Cal.		April 6, 1909
MERRIMAN, THADDEUS. Asst. to the Chf. Engr., Board of Water Supply, 299 Broadway, New York City	Jun. Assoc. M.	April 4, 1899 April 1, 1908
MESA, ANTONIO ESTEBAN. Oquendo 2 "A," Havana, Cuba		Jan. 1, 1896
MEYERS, ALFRED MOYER. Asst. Engr., Kansas City Structural Steel Co., Kansas City, Mo.		Oct. 5, 1904
MEYERS, CLARENCE WILLIAM. Asst. Engr., Rapid Transit Subway Constr. Co., 314 Riverside Drive, New York City	Jun. Assoc. M.	Sept. 1, 1903 Oct. 2, 1907
MIDDLETON, ROBERT JAMES. Asst. Engr., B. & B. Dept., C., M. & St. P. Ry., 1313 Sherman Ave., Evanston, Ill.		Dec. 4, 1907
MILLER, CLIFFORD NEVILLE. 24 Waterworks Bldg., Kansas City, Mo.	Jun. Assoc. M.	June 4, 1891 Feb. 5, 1896
MILLER, GEORGE SOTER. 262 Pearl St., Burlington, Vt.		April 1, 1903
MILLER, HIRAM. Rockfall, Conn.		Jan. 5, 1909
MILLER, MAX MERRILL. Designer, Bridge Dept., N. Y. C. & H. R. R. R. Co., 335 Madison Ave., New York City (Res., Puritan Ave., Colonial Heights, Yonkers, N. Y.)		Oct. 7, 1908

		Date of Membership.
Miller, Stanley Alfred. Director, Irrigacion de Azua, Azua, Santo Domingo	Jun. Assoc. M.	Feb. 4, 1902 April 6, 1909
Miner, James Henry. Asst. Engr., U. S. Reclamation Service, Montrose, Colo	Jun. Assoc. M.	Mar. 31, 1903 Nov. 8, 1909
Minniss, George Stewart. Prin. Asst. Engr. with George A. Ricker, 702 Ellicott Sq., Buffalo, N. Y		Dec. 5, 1906
Mirick, Alfred Stowe. Asst. Engr., New York State Barge Canal, 144 Jay St., Albany, N. Y		Oct. 5, 1909
Mitcham, George Nathan. Prof. of Civ. Eng., Alabama Polytechnic Inst., Auburn, Ala		Nov. 8, 1909
Mitchell, Lester Hale. Care, U. S. Reclamation Service, Glendive, Mont		Oct. 5, 1909
Mobberly, Henry Peyton. Civ. and Hydr. Engr., 400½ South St., Springfield, Mo		April 3, 1907
Moler, William Griffith. Mgr., New York Office, Corrugated Bar Co., 1 Madison Ave., New York City		Jan. 3, 1900
Móller, Louis. 130 Lafayette Ave., Detroit, Mich		May 1, 1907
Mönniche, Tollef Bache. Designing Engr., Dept. of Constr. and Eng., Isthmian Canal Comm., Culebra, Canal Zone, Panama		Oct. 3, 1906
Monsarrat, Nicholas Daubeney. Second Vice-Pres., Sunday Creek Co., Outlook Bldg., Columbus, Ohio	Jun. Assoc. M.	Feb. 5, 1895 Sept. 2, 1903
Montgomery, Ernest. Div. Engr., The Orchard Constr. Co. of Chicago, Palisades, Colo		Oct. 5, 1909
Moody, Joseph Elbert. With Hurley, Mason Co., Engrs. and Contrs., Tacoma, Wash		Oct. 7, 1908
Moore, Egbert Jessup. Chf. Engr., Turner Constr. Co., 11 Broadway, New York City; Address, 80 Cornell Ave., Yonkers, N. Y	Jun. Assoc. M.	Mar. 31, 1903 Feb. 7, 1906
Moorehead, Theodore Parker. P. O. Box 1129, El Paso, Tex		Oct. 5, 1909
Moorshead, Alfred Lee. Res. Engr., Bergen Hill Cut, Erie R. R., 649 Summit Ave., Jersey City (Res., 49 Locust Ave., Arlington), N. J		April 3, 1907
Moorshead, Thomas Courtney. Chf. Engr., Ill. Terminal R. R.; Supt. of Constr., Illinois Glass Co., Alton, Ill		Mar. 1, 1905
More, Charles Church. Associate Prof. of Civ. Eng., Univ. of Washington, University Station, Seattle, Wash	Jun. Assoc. Assoc. M.	May 2, 1899 Feb. 6, 1907 Mar. 31, 1908
Morey, Richard. Pres., Morey-Faulhaber Constr. Co., Chemical Bldg., St. Louis, Mo		Jan. 2, 1901
Moritz, Ernest Anthony. Sunnyside, Wash	Jun. Assoc. M.	Oct. 6, 1908 Jan. 4, 1910
Morrill, George Pillsbury. Ingeniero Primero de Obras Publicas, Sagua la Grande, Cuba		Jan. 2, 1907

		Date of Membership.
MORRILL, WILBUR NATHANIEL. Managing Engr. for The Weber Co., 803 Lincoln Bank Bldg., Louisville, Ky		Jan. 8, 1908
MORRISON, CHARLES EDWARD. Columbia Univ., New York City		Oct. 5, 1909
MORRISON, JAMES LUTHER. Civ. & Min. Engr. (Morrison Bros.), 27 Thornton Bldg., Bluefield, W. Va		Nov. 4, 1908
MORROW, FREDERICK EDGAR. Field Engr., Board of Superv. Engrs., Chicago Traction, 181 La Salle St., Chicago, Ill.		Nov. 8, 1909
MORSE, HOWARD SCOTT. Res. Engr. with Commrs. of Sewerage, 602 Equitable Bldg., Louisville, Ky		Oct. 2, 1907
MORSSEN, CHARLES MICHAEL. Cons. Engr. and Contr., 17 Place d'Armes Hill, Montreal, Que., Canada		June 5, 1907
MOSS, CASTLE PRENTICE. Res. Engr. for Waddell & Harrington, 1486 Granville St., Vancouver, B. C., Canada		June 3, 1903
MOSS, ROBERT EDWARD. Structural Engr., 126 Liberty St., New York City		May 2, 1900
MOSS, ROBERT FAULKNER. Columbia, Mo	Jun.	Nov. 1, 1904
	Assoc. M.	Mar. 2, 1909
MOTT, WILLIAM ELTON. Prof. of Civ. Eng., Carnegie Technical Schools, Pittsburg, Pa		Mar. 5, 1902
MOULD, GEORGE ALEXANDER HUTCHINGS. With Geo. A. Fuller Co.; Res., 255 West 111th St., New York City		Dec. 7, 1904
MOZART, WILLIAM JACOB. Cons. and Const. Engr., 93 Hancock St., Malden, Mass		April 3, 1907
MULLER, LESLIE. Care, H. & M. R. R., 124 West 31st St., New York City		Feb. 1, 1910
MUNN, ALEXANDER MAJORS. Nebraska City, Nebr		Jan. 3, 1906
MUNN, MORTIMER ADAM. Contr. Engr., 33 Elberon Ave., East Cleveland, Ohio		July 9, 1906
MUNROE, HERSEY. Topographer, U. S. Geological Survey, Washington, D. C		Mar. 5, 1902
MURPHY, JOHN JOSEPH. Asst. Engr., Bureau of Street Openings, Dept. of Public Works, 13 Park Row, New York City (Res., 70 Park Hill Ave., Yonkers, N. Y.)		Mar. 2, 1909
MURPHY, JOSEPH EDGAR. Office Engr., C., B. & Q. Ry., 209 Adams St., Room 63, Chicago, Ill		Sept. 2, 1903
MURPHY, ROBERT LINCOLN. Dist. Sales Mgr., Corrugated Bar Co., 1402 National Bank of Commerce Bldg., St. Louis, Mo		Nov. 7, 1906
MURRAY, CHARLES WARREN. Fitzgerald, Ga		Dec. 2, 1903
MURRAY, RAY. 1024 Witherspoon Bldg., Philadelphia, Pa	Jun.	Oct. 6, 1903
	Assoc. M.	Dec. 4, 1907
MURRAY, SAMUEL. Bridge Engr., Oregon & Washington R. R., 636 Central Bldg., Seattle, Wash		Jan. 8, 1908
MYERS, CHESTER JOHN. Asst. Engr., N. Y. State, 15 N. Church St., Cortland, N. Y	Jun.	Oct. 1, 1901
	Assoc. M.	Jan. 4, 1905

		Date of Membership.
Myers, Edward Warren. Civ. and Hydr. Engr., 346 Arcade Bldg., Greensboro, N. C.		Oct. 2, 1901
Myers, John Hays. Engr., Second Div., Public Service Comm. for the First Dist., 2630 Broadway, New York City	Jun. Assoc. M.	Dec. 5, 1893 Oct. 5, 1898
Myers, John Henry. B. & C. Dept., Penna. Steel Co., Steelton, Pa.		June 1, 1909
Myers, William Madison. 528 Fairmont Ave., Winchester, Va.		Oct. 3, 1906

Nash, Frank Dana. Div. Engr., Bureau of Public Works, Manila, Philippine Islands		May 4, 1909
Neff, Frank Howard. Prof. of Civ. Eng., Case School of Applied Science; Address, 2087 East 105th St., Cleveland, Ohio		May 6, 1903
Nelson, Alexander Howard. Atlantic City, N. J.	Jun. Assoc. M.	Nov. 1, 1898 April 5, 1905
Nelson, Arthur Thomas. Sales Engr., Trussed Concrete Steel Co., The Waldorf, Seattle, Wash.		Jan. 8, 1908
Nelson, Clarence Lotario. U. S. Geological Survey, Washington, D. C.		Oct. 3, 1906
Nelson, Fred Burgess. Asst. Engr., Dept. of Water Supply, Gas and Electricity, New York City; Address, 52 Halsted St., East Orange, N. J.		April 6, 1909
Nelson, William. Gen. Mgr., The Georgian Mfg. Co., Binghamton, N. Y.		June 6, 1900
Neumeyer, Robert Engler. Borough Engr. of the Towns of Bethlehem and South Bethlehem, 501 Market St., Bethlehem, Pa.	Jun. Assoc. M.	May 31, 1892 Mar. 3, 1897
Neville, Colone Will Jackson. Civ. and Contr. Engr.; Pres., The Fireproofing Co., 1020 Maison Blanche Bldg., New Orleans, La.	Jun. Assoc. M.	Oct. 1, 1901 June 3, 1903
Newbegin, Parker Cleaveland. Maintenance Engr., Bangor & Aroostook R. R., Houlton, Me.		May 1, 1907
Newberry, Spencer Baird. Vice-Pres. and Gen. Mgr., Sandusky Portland Cement Co., Sandusky, Ohio		Jan. 6, 1897
Newell, Herbert Damon. Engr., U. S. Reclamation Service, Hermiston, Ore.		Dec. 7, 1904
Newhall, William Barrett. Cons. Engr., 2702 Humboldt Ave., South, Minneapolis, Minn.		Oct. 7, 1908
Newman, Arthur Traver. Care, A. L. Webster, 82 Wall St., Room 706, New York City		Nov. 8, 1909
Newton, Samuel Donald. City Engr., Knoxville, Tenn.		June 1, 1909
Nial, William Augustine. 39 West 126th St., New York City.		July 9, 1906
Nichols, Adelbert Reid. Engr., Thompson-Starrett Co., New York City; Res., 184 Prospect Park West, Brooklyn, N. Y.		Mar. 6, 1907

		Date of Membership.
NICHOLS, CLARENCE HICKS. Long Acre Hotel, 47th St., New York City		April 6, 1904
NICHOLS, HENRY FRANCIS. Gen. Mgr. and Engr., James Hill & Sons, 63 Grenfell St., Adelaide, South Australia		Oct. 1, 1902
NIMMO, JAMES VALENCE. Canadian Northern Ry., 135 Hastings St., Room 14, Vancouver, B. C., Canada		Sept. 5, 1906
NIXON, COURTLAND. Depot Quartermaster, Isthmian Canal Comm., Cristobal, Canal Zone, Panama		Nov. 1, 1905
NOBLE, CLARENCE WARREN. Contr. Fire-Proofing Engr., 117 Home Life Bldg., Toronto, Ont., Canada		Feb. 3, 1904
NOBLE, FREDERICK CHARLES. Div. Engr., Public Service Comm. for the 1st Dist., 4 Court Sq., Brooklyn, N. Y.		June 4, 1902
NOBLE, WALTER EDWIN. Asst. Engr., City Engr.'s Dept., City Hall, Fall River, Mass		April 2, 1902
NOERR, ROBERT COLLYER. Designing Engr., Berlin Constr. Co., Berlin (Res., 120 Huntington St., Hartford), Conn		Jan. 2, 1907
NORCROSS, PAUL HOWES. 1622 Candler Bldg., Atlanta, Ga		July 9, 1906
NORCROSS, THEODORE WHITE. Acting Dist. Engr., U. S. Geological Survey, Water Resources Branch, 6 Beacon St., Boston, Mass		Nov. 8, 1909
NORRIS, WALTER HENRY. Bridge Engr., Maine Cent. R. R., 238 St. John St., Portland, Me		Sept. 6, 1905
NORTH, ARTHUR TAPPAN. 510 Odd Fellows Bldg., St. Louis, Mo.		Feb. 7, 1906
NORTHROP, ALBERT ALLEN. Asst. Engr., Board of Water Supply, New York City, Brown Station, N. Y		July 9, 1906
NOSKA, GEORGE ALBERT. Care, Waid & Willauer, 156 Fifth Ave., New York City	Jun. Assoc. M.	Mar. 31, 1896 Sept. 3, 1902
NOYES, HARRY LINCOLN. Mech. Engr., Union Carbide Co., 79 Wall St., New York City		June 5, 1901
NYE, ALGERNON SIDNEY. 351 West 51st St., New York City	Jun. Assoc. M.	July 2, 1890 April 5, 1905
OAKES, JOHN CALVIN. Capt., Corps of Engrs., U. S. A., Trust Bldg., Galveston, Tex		May 1, 1907
OAKES, LUTHER STEVENS. Chehalis, Wash		Jan. 4, 1905
OAKLEY, GEORGE ISRAEL. Asst. Engr., Contract No. 30, N. Y. State Barge Canal, Herkimer, N. Y	Jun. Assoc. M.	Oct. 6, 1903 Nov. 6, 1907
OBREITER, JOSEPH WILLIAM. 908 Castle Point Terrace, Hoboken, N. J		Nov. 6, 1907
O'CONNOR, CORNELIUS JOSEPH. Sewer Bureau, Municipal Bldg., Williamsbridge, New York City	Jun. Assoc. M.	Mar. 1, 1904 June 5, 1907
O'CONNOR, JOHN ADAM. Res. Engr., State Engr.'s Dept., Albany, N. Y		April 1, 1908

		Date of Membership.
O'HEARN, JOHN LYNCH. Cons. Civ. Engr., Clinton, Okla	Jun. Assoc. M.	Feb. 5, 1907 Nov. 4, 1908
OINOUYE, CHIKAO. Care, Koto-Kogio-Gakko, Sendai, Japan		Feb. 7, 1906
OLBERG, CHARLES REAL. Supt. Irrig., Indian Service, 522 Bumiller Bldg., Los Angeles, Cal		May 7, 1902
OLDER, CLIFFORD. Bridge Engr., Ill. Highway Comm., Springfield, Ill		Oct. 4, 1905
OLDS, CLARK. Erie, Pa		Mar. 1, 1899
OMBERG, JAMES ADOLPHUS, JR. Cons. Engr., 526 Goodwyn Inst. Bldg., Memphis, Tenn		April 1, 1903
O'NEIL, JOSEPH. City Engr., 608 Olive St., Leavenworth, Kans.		Feb. 1, 1910
OPDYCKE, HENRY GORTON. 30 Church St., New York City		Sept. 7, 1904
OPSAHL, HILMAR TORLEIV. 47 Bogstadveien, Christiania, Norway		April 3, 1907
ORR, ALEXANDER. Supt., Water-Works, Gloversville, N. Y	Jun. Assoc. M.	June 4, 1901 Feb. 5, 1902
ORTIZ, EDUARDO. 48 Avenida del 16 de Septiembre, City of Mexico, Mexico	Jun. Assoc. M.	Nov. 4, 1902 May 1, 1907
OSBORN, OLLIE STEELE. Care, Toltec Club, El Paso, Tex		Oct. 2, 1901
OSBORNE, GEORGE FREDERICK FOLGER. Royal Engrs., Care, Cox & Co., Fort Bombay, British India		Dec. 7, 1904
OSBOURN, HENRY VAN BUREN. 1618 Real Estate Trust Bldg., Philadelphia, Pa		Sept. 3, 1902
OTT, SAMUEL JACOB. 59 William St., East Orange, N. J		Feb. 6, 1907
OWEN, ARTHUR EDMUND. Prin. Asst. Engr., C. R. R. of N. J., 81 Grove St., Montclair, N. J		May 3, 1905
OWEN, ELIJAH HUNTER. Supt. of Constr., Osborn Eng. Co., Cleveland, Ohio		June 6, 1906
OWENS, JAMES MICHAEL. Asst. Engr. in Chg., Dept. of Street Impvts., Office of City Engr., Board of Public Works, San Francisco, Cal	Jun. Assoc. M.	April 4, 1905 Jan. 8, 1908
PACE, FULTON. Asst. Irrig. Engr., Guayama, Porto Rico	Jun. Assoc. M.	Nov. 5, 1907 Feb. 2, 1909
PADDOCK, HOWARD CHARLES. Designing Engr., The Turner Constr. Co., 11 Broadway, New York City		June 1, 1909
PAIGE, JASON. 220 Audubon Ave., New York City	Jun. Assoc. M.	Feb. 5, 1907 Feb. 2, 1909
PAINE, HIBBARD ATWILL. Road Engr., Caroline County, Denton, Md		Feb. 4, 1903
PALMER, GEORGE BRUCE. R. of W. Engr., Penn. Lines W. of Pitts., 1106 Union Station, Pittsburg, Pa		April 6, 1909
PALMER, MARSHALL BARKER. Asst. Engr., Syracuse Water Supply, 112 Court House (Res., 104 Amherst Ave.), Syracuse, N. Y		June 5, 1907

		Date of Membership.
Paquette, Charles Alfred. Asst. Chf. Engr., C., C., C. & St. L. Ry., Cincinnati, Ohio		April 6, 1898
Park, James Caldwell. 20 South Ave., Cranford, N. J.	Jun. Assoc. M.	Feb. 28, 1905 June 3, 1908
Parker, Charles Frederic. Mine Operator, Care, Parker & Hamilton, Coneto, Dgo., Mexico	Jun. Assoc. M.	June 5, 1900 Sept. 2, 1903
Parker, John Castlereagh. Mech. and Elec. Engr., Rochester Ry. & Light Co., Rochester, N. Y.	Jun. Assoc. M.	Dec. 6, 1904 May 6, 1908
Parker, Philip À Morley. Care, Capt. Parker, R. N., Philipsfield House, St. Michaels, Ashford, Kent, England		Mar. 6, 1907
Parker, Richard Denny. Engr., R. R. Comm. of Texas, Austin, Tex.	Jun. Assoc. M.	June 3, 1902 Mar. 7, 1906
Parsons, Archibald Livingstone. Civ. Engr., U. S. N., U. S. Naval Academy, Annapolis, Md.		May 7, 1902
Parsons, Charles Edward. 144 Edgewood Ave., Atlanta, Ga.		May 6, 1903
Parsons, Harold Ashton. Stamford, Conn.		May 1, 1907
Patch, Homer Austin. Contr. Engr., Minneapolis Steel & Machinery Co., 313 E. P. & S. W. Bldg., El Paso, Tex.		Jan. 8, 1908
Patterson, Clair Brandon. Res. Engr., L. S. & M. S. Ry., Darrowville, Ohio		July 1, 1909
Patterson, Robert Youngman. Asst. Engr., Boston & Albany R. R., Springfield, Mass.		Jan. 8, 1908
Pawling, George Franklin. Gen. Mgr., Bergdoll & Pawling, Engrs. and Contrs., Broad and Vine Sts., Philadelphia (Res., Ridley Park), Pa.		April 4, 1906
Payne, James Henry. 543 Pacific Elec. Bldg., Los Angeles, Cal.		Feb. 5, 1908
Pearse, Langdon. Asst. Engr. in Chg., Sewage Disposal Investigations, The Sanitary Dist. of Chicago, 1500 American Trust Bldg., Chicago, Ill.	Jun. Assoc. M.	Jan. 6, 1903 Oct. 7, 1908
Pease, Frederick Atwood. Gen. Mgr., The F. A. Pease Eng. Co., Williamson Bldg., Cleveland, Ohio		June 5, 1907
Peck, John Gates. Chf. Engr. and Shop Mgr. for the Receivers of J. B. & J. M. Cornell Co., Cold Spring, Putnam Co., N. Y.		Sept. 3, 1902
Peck, Myron Hall. Prof. of Civ. Eng., Imperial Pei Yang Univ., Tientsin, China		Jan. 5, 1909
Pellissier, George Edward. Supt., Goldschmidt Thermit Co., 90 West St., New York City	Jun. Assoc. M.	Feb. 28, 1905 July 1, 1909
Pendergrass, Robert Allen. Chf. Draftsman, McClintic-Marshall Constr. Co., Pittsburg, Pa.		June 3, 1908
Peotter, Reuben Sylvester. Massena, N. Y.		Nov. 30, 1909
Perkins, Albert Henry. Res. Engr., New York State Water Supply Comm., Albany, N. Y.		Feb. 7, 1906

		Date of Membership.
Perkins, Philo Sackett. Asst. Engr., N. Y., N. H. & H. R. R., 59 Chester Ave., Providence, R. I.	Jun. Assoc. M.	Mar. 5, 1890 April 3, 1895
Perley, Alan Bigelow. Cons. Engr. (Perley & Davis), 621 Drexel Bldg., Philadelphia, Pa.		June 1, 1909
Perring, Henry Garfield. 5421 Vine St., Philadelphia, Pa.		Nov. 6, 1907
Perrot, Emile George. 1211 Arch St., Philadelphia, Pa.		Feb. 6, 1907
Perry, Francis William. Engr. in Chg. of Constr., Municipal Bldg., New York City; Address, 214 Parkside Ave., Brooklyn, N. Y.		Jan. 5, 1909
Petersen, Charles Walter. Engr. of Track Elevation, Rock Island Lines, 802 La Salle St. Station, Chicago, Ill.		Feb. 6, 1907
Peterson, John. Asst. Engr.-Designer, Board of Water Supply, 299 Broadway, Room 1019, New York City		Jan. 3, 1906
Pettebone, Lauren Augustus. 307 Buffalo Ave., Niagara Falls, N. Y.		Feb. 2, 1909
Pfau, Julius Welch. Engr. of Constr., N. Y. C. & H. R. R. R., Grand Central Station, New York City		Dec. 2, 1903
Pfeifer, Herman Julius. Engr., M. of W., Terminal R. R. Assoc. of St. Louis, St. Louis Merchants Bridge Terminal Ry. Co., 2145 Blendon Pl., St. Louis, Mo.		Sept. 6, 1899
Pfeiffer, George Whitfield. Supt., Spanish American Iron Co., Santiago de Cuba, Cuba		Oct. 5, 1904
Pflueger, Alvin Cyrus. Asst. Engr., P. T. & T. R. R. Co., 140 Third St., Long Island City, N. Y.		June 5, 1907
Phillips, Frederick Clinton. Jacksonville, Fla.	Jun. Assoc. M.	June 4, 1895 April 4, 1900
Phillips, Howard Crathorne. Chf. Engr., A., T. & S. F. Ry. Coast Lines, Los Angeles, Cal.	Jun. Assoc. M.	April 5, 1892 Sept. 6, 1899
Phillips, Silas Bent. East Seattle, Wash.		Aug. 31, 1909
Phillips, Theodore Clifford. Civ. and Hydr. Engr., 4118 Ellis Ave., Chicago, Ill.		Mar. 2, 1904
Phillips, William Hale. Box 1023, Spokane, Wash.	Jun. Assoc. M.	Nov. 1, 1904 May 4, 1909
Pickwick, Edwin Job. Res. Engr., State Barge Canal, Parker Bldg., Schenectady, N. Y.		Jan. 5, 1909
Pierce, George Abel. Draftsman, Mo. Pac. Ry., Room 801, Mo. Pac. Bldg., St. Louis, Mo.		Jan. 5, 1909
Pierce, James Wilson. Durham, N. C.		Feb. 3, 1904
Pill, John Richards. Gen. Supt., Galloway Coal Co.; Vice-Pres. and Gen. Mgr., Choctaw Coal & Min. Co., 1111 Twelfth Ave. South, Birmingham, Ala.		Feb. 7, 1906
Pillsbury, George Bigelow. Capt., Corps of Engrs., U. S. A., West Point, N. Y.		Dec. 7, 1904
Pires do Rio, José. 93 rua Quitanda, Rio de Janeiro, Brazil		Jan. 4, 1910

		Date of Membership.
Pistor, George Emil John. Designing Engr., Hay Foundry & Iron Works, 114 East 28th St., New York City	Jun. Assoc. M.	Dec. 3, 1901 July 10, 1907
Pitkethly, David Thomas. Asst. Engr., Bureau of Sewers, Borough of Brooklyn, 330 Etna St., Brooklyn, N. Y		April 6, 1909
Pitts, Thomas Dorsey. Div. Engr., Sewerage Comm., 904 American Bldg., Baltimore, Md.	Jun. Assoc. M.	Dec. 7, 1897 June 4, 1902
Plock, Albert Francis. Chf. Engr., The Northwestern Iron Co., Mayville, Wis		Nov. 8, 1909
Plogsted, Walter John. Res. Engr. and Supt. of Constr., Gen. Ry. Signal Co., 527 Fifth Ave., New York City	Jun. Assoc. M.	Oct. 6, 1903 May 4, 1909
Poe, Harry Tinker, Jr. City Engr., and Consultation, Greenville, S. C		Feb. 5, 1908
Poe, Joseph Ralph. Civ. and Structural Engr., 1458 Lakewood Ave., Lakewood, Ohio		Feb. 5, 1908
Pohl, Charles Andrew. Care, John Bogart, 141 Broadway, New York City		Oct. 2, 1907
Polk, Armour Cantrell. Asst. Engr., G. C. & S. F. Ry., Pauls Valley, Okla	Jun. Assoc. M.	Oct. 6, 1903 May 2, 1906
Pond, Harry Bradford. 1432 Crotona Park East, New York City		May 4, 1909
Poole, Charles Arthur. Engr., Ferguson Contr. Co., 37 Wall St., New York City		June 5, 1907
Poole, John Hudson. Capt., Corps of Engrs., U. S. A., Fort Leavenworth, Kans		June 1, 1909
Popert, William Hopf. Contr. Engr., Am. Bridge Co. of N. Y., 906 Crocker Bldg., San Francisco, Cal		Nov. 4, 1908
Porter, James Madison. Prof., Civ. Eng., Lafayette Coll., Easton, Pa		May 4, 1892
Porter, Sam Graham. Chf. Engr., Arkansas Val. Sugar Beet & Irrigated Land Co., Holly, Colo		Oct. 2, 1907
Post, Chester Leroy. Supt. with The Unit Constr. Co., Holland Bldg., St. Louis, Mo		July 1, 1908
Post, William Schuyler. 1111 Union Trust Bldg., Los Angeles, Cal		May 1, 1901
Potter, Alexander. Cons. Engr., 114 Liberty St., New York City	Jun. Assoc. M.	Jan. 4, 1888 Jan. 6, 1892
Potter, James Rowland. 9 Ardmore Ave., Ardmore, Pa		June 6, 1906
Potts, Clyde. Civ. and San. Engr., 30 Church St., New York City	Jun. Assoc. M.	Dec. 3, 1901 Oct. 4, 1905
Powell, Thomas Jett. Surface Div., Engr. Dept., District of Columbia (Res., 13 Third St., N. E.), Washington, D. C.		Mar. 2, 1909
Pratt, Arthur Henry. Asst. Designing Engr., Board of Water Supply, 299 Broadway, New York City		July 1, 1908

		Date of Membership.
PRATT, HENRY BLANCHARD. Asst. Engr., J. R. Worcester & Co.; Res., 750 Lexington St., Waltham, Mass		June 1, 1909
PRATT, JOEL MARSH. U. S. Asst. Engr., U. S. Engrs. Office (Res., 24 South Catherine St.), Mobile, Ala		July 1, 1909
PRENTICE, WILLIAM HENDRY, JR. Asst. Engr., Mo. Pac. Ry., 4143 Lindell Boulevard, St. Louis, Mo		April 4, 1906
PRESSEY, HENRY ALBERT. Hibbs Bldg., Washington, D. C		May 1, 1901
PRESTON, CHARLES HENRY, JR. Civ. and Cons. Engr., Holmes Bldg., Grand St., Waterbury, Conn		Oct. 2, 1907
PRESTON, HARRY LONGYEAR. Asst. Dist. Engr., N. Y. C. & H. R. R. R. Co., Jordan, N. Y		April 1, 1908
PRICE, PAUL LEON. Chf. Engr., Geo. B. Post & Sons, Archts., 347 Fifth Ave., New York City		Oct. 3, 1906
PRICE, PHILIP WALLIS. County Engr.'s Office, Court House, Pittsburg, Pa	Jun. Assoc. M.	April 2, 1901 Feb. 5, 1908
PRIEST, BENSON BULKELEY. Care, Am. Bridge Co., 30 Church St., New York City		April 4, 1906
PRIME, ALFRED COXE. Engr., P. R. R., 1008 Spruce St., Philadelphia, Pa		Nov. 4, 1908
PRINCE, ARTHUR DICKSON. Asst. Engr., Public Service Comm., First Div., 154 Nassau St. (Res., 274 West 94th St.), New York City	Jun. Assoc. M.	May 5, 1896 Oct. 3, 1900
PRITCHARD, CLIFFORD MOSES. Contr. Engr., Kans. City Structural Steel Co. of Argentine, Kans., 118½ W. Main St., Oklahoma, Okla		April 1, 1903
PRITCHARD, PHILIP MORRIS. Chf. Engr., United Alkali Co., Ltd., Widnes, Lancashire, England		June 6, 1900
PRITCHETT, CHARLES MARCELLUS. Dist. Engr., Third Dist., Manila, Philippine Islands		Sept. 2, 1903
PROCTOR, LEWIS JEFFERSON. Gen. Mgr., Porto Rico Gen. Telephone Co., San Juan, Porto Rico		Mar. 1, 1905
PROCTOR, RALPH FENNO. Care, A. L. Register & Co., 112 N. Broad St., Philadelphia, Pa	Jun. Assoc. M.	June 3, 1902 Oct. 4, 1905
PROUTY, EDWARD NATHAN. Chf. Engr., Lassen-Willow Creek Water Co., Purser, Lassen Co., Cal		Feb. 3, 1904
PULLAR, WILLIAM MURRAY. "St. Kitts," Essendon, Victoria, Australia		Aug. 31, 1909
QUICK, ALFRED MERRITT. Pres., Water Board and Water Engr., City Hall, Baltimore, Md		Oct. 5, 1898
QUIMBY, CHARLES HENRY, JR. Res. Engr., N. Y., W. & B. Ry., 220 So. Fulton Ave., Mt. Vernon, N. Y		Dec. 4, 1907
QUINBY, CHARLES EDWARD. Chf. Engr. and Supt. of Constr., Ludlow Mfg. Co., Ludlow, Mass		Sept. 6, 1905

		Date of Membership.
Race, John Marble. Housatonic, Mass.		Mar. 5, 1902
Rainbow, John Roworth. Archt., 3 East 33d St., New York City		Jan. 6, 1904
Ramsey, Guy Robert. Apartment C 8, The Espanola, Spokane, Wash.		Oct. 7, 1903
Randolph, John Hampden, Jr. P. O. Box 193, Norfolk, Va.		Dec. 5, 1906
Rankin, Harry Howard. Civ. and Min. Engr., 1321 Park Bldg. (Res., 1207 South Negley Ave.), Pittsburg, Pa.		Mar. 1, 1905
Rannells, Clarence J. Little Hocking, Ohio		Oct. 3, 1906
Ranney, Charles Garfield. Leveler, N. Y. State Eng. Dept., Mohawk, N. Y.	Jun. Assoc. M.	April 30, 1907 Feb. 1, 1910
Ranson, Birtram Willard. Mgr., Reinforced Concrete Dept., The Gen. Fireproofing Co., Youngstown, Ohio	Jun. Assoc. M.	Sept. 3, 1907 Oct. 5, 1909
Raster, Walther. With E. C. & R. M. Shankland, 6743 Perry St., Chicago, Ill.	Jun. Assoc. M.	Feb. 4, 1902 Mar. 6, 1907
Ravenscroft, Edward Hawks. 4757 E. Ravenswood Pk., Chicago (Res., Glencoe), Ill.		Nov. 6, 1907
Raynor, Clarence Webster. Chf. Engr. for C. G. Sheely, 414 Tabor Opera House Blk., Denver, Colo.	Jun. Assoc. M.	Feb. 4, 1902 April 6, 1904
Reed, Alfred Clare. Supt., The Spanish-American Iron Co., Felton, Oriente, Cuba		June 5, 1907
Reed, William Belden, Jr. Vice-Pres. and Treas., The White Plains Constr. Co., 133 Railroad Ave., White Plains, N. Y.	Jun. Assoc. M.	Dec. 1, 1896 June 5, 1907
Reedy, Oliver Thomas. Asst. Engr., U. S. Reclamation Service, Orman, S. Dak.		June 6, 1906
Reel, Charles Gordon. Vice-Pres. and Gen. Mgr., Kingston Consolidated R. R. Co., 320 Broadway, Kingston, N. Y.		June 5, 1907
Reeves, Carl Howell. Asst. Civ. Engr., Seattle Elec. Co., 4722 Latona Ave., Seattle, Wash.	Jun. Assoc. M.	May 2, 1905 July 1, 1909
Reich, Phillip Jacob. Engr., Toledo Plant, Am. Bridge Co., Toledo, Ohio		June 5, 1907
Reichardt, Walter Frederick. Cons. Engr., 102 Louisiana St., Little Rock, Ark.	Jun. Assoc. M.	Jan. 31, 1905 July 10, 1907
Reid, Homer Austin. Asst. Engr., Bureau of Bldgs., Borough of Manhattan (Res., 29 Hamilton Terrace), New York City		Dec. 4, 1901
Reimer, Arthur Adams. Engr., Water Dept., City Hall, East Orange, N. J.		Mar. 6, 1907
Reimer, Frederic Adams. City Engr., 51 North Maple Ave., East Orange, N. J.		April 6, 1909
Reynolds, Justin Oakley. Engr. of Elevated Lines, Brooklyn Rapid Transit System, 85 Clinton St., Room 1000, Brooklyn, N. Y.	Jun. Assoc. M.	Oct. 6, 1896 Dec. 5, 1900

		Date of Membership.
Reynolds, Lafayette Clowe. Res. Engr., Gen. Elec. Co. (Res., 61 Robinson St.), Schenectady, N. Y.	Jun. Assoc. M.	Feb 6, 1906 Dec. 1, 1908
Rhoades, Theodore Eckford. Chf. Engr., Whitney-Steen Co., 135 Broadway, New York City		June 1, 1909
Rhodes, Fred Dana. Cons. Engr., 140 Cedar St., New York City	Jun. Assoc. M.	June 6, 1899 Nov. 6, 1901
Rice, Herbert Allan. Associate Prof., Civ. Eng., Univ. of Kansas, 1233 Massachusetts St., Lawrence, Kans		June 7, 1905
Rice, Ray Howard. The Monitor, Granby St., Norfolk, Va		July 1, 1909
Richardson, Clinton Leroy. Contr. Engr., Atlanta, Ga	Jun. Assoc. M.	Sept. 2, 1902 Oct. 2, 1907
Richardson, James Herbert. Care, Erie R. R. Co., Dept. of Bridges and Bldgs., 50 Church St., New York City		Jan. 2, 1907
Richardson, John Francis. Cons. Engr., 43½ Second St., Portland, Ore	Jun. Assoc. M.	Oct. 3, 1899 June 5, 1907
Richardson, Rex Densmore. 1035 Woodlawn Ave., Scranton, Pa		Aug. 31, 1909
Richmond, Julian Pierre William. Asst. Engr., Board of Water Supply, 299 Broadway, New York City (Res., Dunwoodie Heights, Yonkers, N. Y.)	Jun. Assoc. M.	Feb. 2, 1904 Dec. 4, 1907
Riedel, John Charles. Instr. of Mechanics, Cooper Union, New York, and Asst. Engr., Bureau of Sewers, Brooklyn, N. Y.; 686 Halsey St., Brooklyn, N. Y		Oct. 4, 1905
Riegler, Louis John. Engr., Pennsylvania Co., Pittsburg (Res., Church Ave., Ben Avon), Pa		Sept. 3, 1902
Riggs, Thomas, Jr. Surv., Alaskan Boundary Survey, 2111 S St., N. W., Washington, D. C		April 6, 1909
Rightmire, Estel Dean. Atlantic City, N. J		Aug. 31, 1909
Rights, Eugene Jesse. 3806 Ridge Ave., Wissahickon, Philadelphia, Pa		Mar. 2, 1909
Ripley, Blair. Care, Canadian Pacific Ry., Outlook, Sask., Canada		April 1, 1908
Ripley, Theron Monroe. Barge Canal Res. Engr., Fulton, N. Y		Nov. 6, 1901
Rittenhouse, Harvey. Engr., M. of W., C. & P. R. R., Box 604, Cumberland, Md	Jun. Assoc. M.	April 4, 1893 Dec. 7, 1898
Robb, Louis Adams. 71 Lincoln Park, Newark, N. J	Jun. Assoc. M.	May 5, 1903 Oct. 5, 1904
Robbins, Dana Watkins. Secy. and Engr., Spuyten Duyvil Constr. Co., 271 West 125th St., New York City		Oct. 3, 1906
Robbins, Franklin Henry. Asst. Engr. Designer, N. Y. Board of Water Supply, 299 Broadway, New York City		July 10, 1907
Robbins, Hallet Rice. Civ. and Min. Engr., P. O. Box 51, Seattle, Wash	Jun. Assoc. M.	Nov. 5, 1907 Nov. 8, 1909

		Date of Membership.
ROBERTS, ARTHUR EDWIN. Structural Engr., 150 Nassau St., New York City (Res., 261 Clinton Ave., Jersey City, N. J.)		April 4, 1906
ROBERTS, HARRY ASHTON. Asst. Supt., Montana Div., Ore. Short Line R. R., Pocatello, Idaho	Jun. Assoc. M.	April 5, 1904 Dec. 5, 1906
ROBINSON, EDWARD WILLIAM. Supt., The Snare & Triest Co., 143 Liberty St., New York City		Oct. 7, 1908
ROBINSON, FRANK MINER. Asst. Engr., West. Pac. R. R., Quincy, Cal		Jan. 2, 1907
ROBINSON, GEORGE LOOMIS. Pres., New York Sewage Disposal Co., 1 Madison Ave., New York City	Jun. Assoc. M.	April 5, 1904 Mar. 7, 1906
ROBINSON, HARRY HAYES. Asst. Engr., Maine Cent. R. R., Portland, Me		May 4, 1904
ROBINSON, HERBERT FULWILER. Supt. of Irrig., U. S. Indian Service, Box 414, Albuquerque, N. Mex		July 10, 1907
ROBINSON, HOLTON DUNCAN. Chf. Engr., Glyndon Contr. Co., 2 Rector St. (Res., 357 West 121st St.), New York City	Jun. Assoc. M.	Mar. 1, 1893 Jan. 3, 1894
ROBINSON, REUBEN TOTMAN. Headquarters Camp, Central Colorado Power Co., Boulder, Colo		Mar. 4, 1908
ROCKENBACH, SAMUEL DICKERSON. Maj., Philippine Scouts, Manila, Philippine Islands		Feb. 6, 1901
ROCKWELL, EDWARD HENRY. Prof. of Structural Eng., Tufts Coll., and Cons. Engr., Tufts College, Mass		June 1, 1909
ROCKWOOD, EDWARD FARNUM. Designing Engr., Eastern Concrete Constr. Co., 101 Tremont St., Boston, Mass		Oct. 5, 1909
RODENBOUGH, JAMES FOSTER. Supt., National Limestone Co., Martinsburg, W. Va		April 3, 1907
ROGERS, HERBERT LINCOLN. Archt., Board of Water Supply, 299 Broadway, New York City		May 3, 1905
ROSE, RUDOLF VIEDT. Eng. Asst., The Niagara Falls Power Co. and Canadian Niagara Power Co.; Res. Engr., Niagara Junction Ry. Co., Niagara Falls, N. Y		April 5, 1905
ROSENBERG, FRIEDRICH. Engr., Charles L. Pitts Co., Contrs., 58 E. Park St., Newark, N. J.	Jun. Assoc. M.	Oct. 2, 1889 Jan. 6, 1892
ROSENTHAL, ALBERT. Pres., Pelham Bay Chemical Co., 699 Broadway, New York City	Jun. Assoc. M.	Jan. 2, 1894 Nov. 6, 1901
ROSEWATER, WILLIAM MARCUS. Commercial Engr. with The Bucyrus Co., South Milwaukee, Wis		June 5, 1901
ROSS, THOMAS ALEXANDER. P. O. Box 185, B. P. O., Shanghai, China		Dec. 3, 1902
ROUNDEY, EUGENE PERONNEAU. Care, Rapid Transit Ry. Co., Syracuse, N. Y		Jan. 6, 1904

		Date of Membership.
ROUSSEAU, HARRY HARWOOD. Member, Isthmian Canal Comm.; Civ. Engr., U. S. N., Culebra, Canal Zone, Panama	Jun. Assoc. M.	June 6, 1893 April 4, 1900
ROUSSEAU, WILLIAM WHITE. Supt. of Constr., Bureau of Water Supply, 47 State St., Troy, N. Y.		Dec. 1, 1908
ROWLAND, WALTER. Draftsman, Isthmian Canal Comm., Corozal, Canal Zone, Panama		Dec. 1, 1908
RUE, MALCOLM ASHER. Care, Am. Bridge Co., Pennsylvania Bldg., Philadelphia, Pa		June 5, 1907
RUGG, WARREN FULLER. Asst. Engr., N. Y. Board of Water Supply, 767 Elm St., Peekskill, N. Y.		Nov. 6, 1907
RUGGLES, CHARLES ARNER. 36 East 23d St., New York City		June 4, 1902
RUNYON, WILLIAM KERPER. Care, Madeira-Mamoré Ry., Manãos, Brazil	Jun. Assoc. M.	April 5, 1898 Oct. 5, 1904
RUSCH, HENRI. Chf. Engr., Bldg. Dept., City Hall, St. Louis, Mo		Nov. 8, 1909
RUST, HENRY PRESTON. Care, Vielé, Blackwell & Buck, 49 Wall St., New York City		Aug. 31, 1909
RYAN, MICHAEL HEALEY. Asst. Engr., N. Y. Rapid Transit Comm., 231 West 125th St., New York City	Jun. Assoc. M.	Dec. 3, 1901 April 1, 1908
SABIN, ALVAH HORTON. Chemist, 432 Sanford Ave., Flushing, N. Y.		Mar. 4, 1896
SACKETT, ROBERT LEMUEL. Prof. of Mun. and San. Eng. and of Hydraulics, Purdue Univ.; Cons. Engr., Lafayette, Ind		Feb. 6, 1907
SADLER, CARL LEON. Topographer, U. S. Geological Survey, Washington, D. C.		April 1, 1908
SAMPLE, WILLIAM DWIGHT. Care, Madeira-Mamoré Ry., P. O. Box 304, Manãos, Brazil		Dec. 1, 1908
SAMPSON, CORNELIUS BRAMHALL. Conejos, Colo		Oct. 5, 1909
SANBORN, JAMES FORREST. Div. Engr., Board of Water Supply, Drawer A, Peekskill, N. Y.		May 4, 1904
SANDERS, FRANCIS NICOLL. 235 State St., Albany, N. Y.		Sept. 3, 1902
SANDERSON, NATHAN HERBERT. 47 Winter St., Boston, Mass.		Feb. 1, 1905
SANFORD, GEORGE OTIS. Project Engr., U. S. Reclamation Service, Williston, N. Dak		Mar. 7, 1906
SANFORD, HARRY CHARLES. Treas. and Chf. Engr., Degnon Contr. Co., 60 Wall St., New York City		Oct. 5, 1898
SANFORD, WALTER EDWARD. Asst. Engr., P. T. & T. R. R. Co., Hammond Pl., Elmhurst, N. Y.		Nov. 30, 1909
SANGER, EDMUND PHIPPS. Mt. Kisco, N. Y.		Feb. 2, 1909
SAPH, AUGUSTUS VALENTINE. 2330 Durant Ave., Berkeley, Cal	Assoc. Assoc. M.	Oct. 1, 1901 June 4, 1907

		Date of Membership.
Sargent, Arthur Winthrop. Junior Engr., U. S. Engr. Office, La Conner, Wash		Sept. 6, 1905
Sargent, Joseph Andrews. Project Engr., Care, Field, Fellows & Hinderlider, Cons. Engrs., 435 Century Bldg., Denver, Colo		Oct. 2, 1901
Sarr, Fred Winton. Div. Engr., N. Y. State Highway Dept., Griffin Bldg., Syracuse, N. Y		May 3, 1905
Sauerman, Henry Burger. Coaling Station Engr., 914 East 66th St., Chicago, Ill		May 1, 1907
Saunders, George Crosby. With Dietrich Bros.; Address, 346 North St., Baltimore, Md		Mar. 1, 1905
Savage, John Lucian. I. O. O. F. Bldg., Boise, Idaho		May 1, 1907
Savage, Seward Merrill. Engr.-Secy. of the Advisory Board, State Hall, Albany, N. Y		April 1, 1908
Sawtelle, Harry Francis. Asst. Engr., Cambridge-Main St. Subway, Bost. Elev. Ry. Co.; Res., 65 Dana St., Cambridge, Mass		Mar. 6, 1907
Sawyer, Donald Hubbard. Treas., Northwestern Eng. Corporation, Spokane, Wash		April 6, 1909
Sawyer, Francis Murphy. Asst. Engr., Constr., P. R. R. Co., 6th and Warm Springs Ave., Huntingdon, Pa		June 6, 1906
Sawyer, George Loyal. Secy., Northwestern Eng. Corporation, 410 Lindelle Blk., Spokane, Wash		Jan. 8, 1908
Sawyer, Wilbur Cyrus. P. O. Box 1401, Los Angeles, Cal	Jun. Assoc. M.	Oct. 6, 1903 Sept. 6, 1905
Scammell, John Kimball. Res. Engr., Public Works, Canada, Box 321, Saint John, N. B., Canada		June 4, 1902
Schaeffler, Joseph Carl. Archt. and Engr., 73 Tremont St., Boston, Mass	Jun. Assoc. M.	Feb. 28, 1905 June 5, 1907
Scharschmidt, Samuel Howard. 2205 East 81st St., Cleveland, Ohio		May 1, 1901
Schermerhorn, Richard, Jr. 29 Broadway, New York City		July 9, 1906
Scheuermann, Hugo Julius. Bridge Designer, Barge Canal Office, Albany, N. Y		Dec. 7, 1904
Schmitt, Ewald. Care, Light House Establishment, Office of Engrs., 12th Dist., Honolulu, Hawaii		Feb. 7, 1900
Schmitz, Frank Curtiss. Care, I. T. Williams & Sons, 25th St. and 11th Ave., New York City		Dec. 6, 1899
Schneider, Anton. Supt., Pierce Phosphate Co.; Supt., The Pebbledale Phosphate Co., Pierce, Fla		May 4, 1898
Schneider, Herman. Dean of the Eng. Coll and Prof. of Civ. Eng., Univ. of Cincinnati, Cincinnati, Ohio		April 2, 1902
Schoder, Ernest William. Asst. Prof. of Experimental Hydraulics and Engr. in Chg. of Hydr. Laboratory, Cornell Univ., Willard Ave., Ithaca, N. Y	Jun. Assoc. M.	Oct. 1, 1901 Jan. 2, 1907

		Date of Membership.
Schrader, Frederick Adolph. Supt., John Monks & Sons, Inc., Gen. Contrs., 82 Beaver St., New York City		Jan. 4, 1910
Schubert, Charles Wesley. Structural Engr. with McClintic-Marshall Constr. Co., Pittsburg (Res., 704 Lincoln Ave., Bellevue), Pa		Aug. 31, 1909
Schuchart, Paul August. Cons. Engr., 115 Nassau St., New York City		Feb. 7, 1906
Schwarze, Carl Theodore. Instr., Civ. Eng. Dept., Cooper Inst., 111 Sherman Pl., South Orange, N. J		May 1, 1907
Schwiers, Frederick William. Contr. Engr., 208 West 104th St., New York City	Jun. Assoc. M.	June 5, 1900 Jan. 7, 1903
Scott, Albert Lyon. 93 Federal St., Boston, Mass		Nov. 7, 1906
Scott, Charles Bruce. Res. Engr., State Highway Comm., P. O. Box 181, Lynchburg, Va		Feb. 3, 1904
Scott, Guy. Engr., M. of W., Toledo Div., Penn. Lines W. of Pitts., Toledo, Ohio	Jun. Assoc. M.	Dec. 1, 1903 Feb. 5, 1908
Scott, William Fry. 507 Traders Bank Bldg., Toronto, Ont., Canada		Oct. 7, 1908
Scrimshaw, James Frederick. Vice-Pres., Salmond Bros. Co., Gen. Contrs., 526 Elm St. (Res., 76 Bennett Ave.), Arlington, N. J		Jan. 8, 1908
Seabury, George Tilley. Asst. Engr., Board of Water Supply, 299 Broadway, New York City	Jun. Assoc. M.	Mar. 31, 1903 Dec. 1, 1908
Searle, Charles Depew. Asst. Engr., Public Service Comm. for the 1st Dist., State of New York, 517 West 113th St., New York City		April 5, 1905
Searle, Lewen Firth. Asst. Engr., Board of Water Supply, New York City, Brown Station, N. Y		May 6, 1908
Sears, Robert Humphry. Dist. Engr., East Indian Ry., Calcutta, India		Dec. 4, 1901
Sears, Thomas Bartlett. Assoc. Prof. of Ry. Eng., Univ. of California, Berkeley, Cal		Oct. 5, 1904
Seastone, Charles Victor. Prin. Asst. to D. W. Mead, Cons. Engr., Madison, Wis		Dec. 5, 1906
Seery, Francis Joseph. Asst. Prof. of Civ. Eng., Coll. of Civ. Eng., Cornell Univ., 25 Willard Ave., University Pl., Ithaca, N. Y		April 3, 1907
Sekiba, Shigeki. Chf. Engr., Yokogawa Bridge Works, 86 Sakaigawa St., Nishiku, Osaka, Japan		Oct. 2, 1907
Selmer, Jens Kristian. Sten Storegaten No. 6, Göteborg, Sweden		Nov. 7, 1906
Senior, Frank Sears. With Arthur McMullen & Co., Montgomery, N. Y	Jun. Assoc. M.	Feb. 28, 1899 Feb. 5, 1908

		Date of Membership.
SENIOR, SAMUEL PALMER. Engr. and Supt., Bridgeport Hydr. Co., 820 Main St. (Res., 2121 North Ave.), Bridgeport, Conn.		Oct. 7, 1903
SESSER, JOHN CORNELIOUS. Eng. Contr., 276 Dayton Ave., St. Paul, Minn.	Jun. Assoc. M.	Sept. 5, 1899 April 1, 1903
SEVERSON, OSCAR MELVERN. State Highway Dept., Rochester, N. Y.		Dec. 6, 1905
SEYFERT, EDGAR ERNEST. Expert Aid, Bureau of Yards and Docks, U. S. Navy Dept., 510 Mills Bldg., Washington, D. C.		July 9, 1906
SHANER, HARRY LINDEN. City Engr.; Chf. Engr., Gravity Water Supply, Lynchburg, Va.		Dec. 7, 1904
SHAW, ARTHUR MONROE. Cons. Engr., Dixon, Ill.		Jan. 3, 1906
SHAW, DAVID JOSEPH. Chappaqua, Westchester Co., N. Y.	Jun. Assoc. M.	April 4, 1905 Mar. 6, 1907
SHAW, FRANK HAROLD. Engr., Water and Sewer Commissions, 503 Woolworth Bldg., Lancaster, Pa.		Oct. 4, 1905
SHEDD, GEORGE GARNETT. Supt. and Engr., J. G. White & Co., Inc., 43 Exchange Pl., New York City		Oct. 3, 1906
SHELDON, CHARLES SMITH. First Asst. Engr., C., H. & D. Ry., Cincinnati, Ohio		June 7, 1905
SHELDON, PAUL. Secy. and Treas., Buck & Sheldon, Inc., 36 Pearl St., Hartford, Conn.		Oct. 5, 1909
SHELEY, HORACE WEST. 723 Judge Bldg., Salt Lake City, Utah	Jun. Assoc. M.	Sept. 5, 1905 July 1, 1909
SHELLENBERGER, LEIDY RUDY. Asst. Engr., for Grand Central Station Archts., 21 West 45th St., Bayonne, N. J.		May 2, 1900
SHELMIRE, ROBERT WARREN. Draftsman, Wheeling & Lake Erie R. R., Cleveland, Ohio		Nov. 30, 1909
SHEPARDSON, JOHN EATON. Res. Engr., Carolina, Clinchfield & Ohio Ry., 514 East Watauga Ave., Johnson City, Tenn.		Jan. 7, 1903
SHERMAN, EDWARD CLAYTON. Designing Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama		Jan. 3, 1906
SHERTZER, TYRRELL BRADBURY. Eng. Draftsman, Public Service Comm. for First Dist., 23 Flatbush Ave., Brooklyn, N. Y.		Oct. 5, 1904
SHIMA, TAKEJIRO. The South Manchuria Ry. Co., Dairen, China.		Mar. 4, 1903
SHIPMAN, CHARLEY EVANS. Engr. with The Gerharz Eng. Co., Box 225, Billings, Mont.	Jun. Assoc. M.	April 3, 1906 Nov. 4, 1908
SHIRE, MOSES EDMUND. Gen. Supt., Hirsh Stein & Co., Hammond, Ind.	Jun. Assoc. M.	April 2, 1901 Jan. 4, 1905
SHOEMAKER, HARRY IVES. Chf. Engr., Kahului R. R. Co., Kahului, Maui, Hawaii		May 4, 1909
SHOEMAKER, LOUIS HENRY. Engr. in Chg., Design, Am. Bridge Co., Frick Bldg., Pittsburg, Pa.		Oct. 4, 1899

		Date of Membership.
Shoemaker, Marshall Ney. Vice-Pres., Am. Concrete-Steel Co., 718 Union Bldg., Newark, N. J.		April 1, 1903
Shonk, John Jenks. Engr. and Contr., 1002 West Broad St., Bethlehem, Pa.		Oct. 5, 1909
Short, William Ambrose Dudley. Chf. Engr., The Continental Signal Co., 46 East Van Buren St., Chicago, Ill.		Feb. 5, 1902
Shortt, John Haggerty. 414 Mutual Life Bldg., Seattle, Wash.		June 7, 1905
Shryock, Joseph Grundy. Designing Engr., Belmont Iron Works, 22d St. and Washington Ave., Philadelphia, Pa.	Jun. Assoc. M.	April 2, 1901 Dec. 5, 1906
Sickman, Albert Franklin. Hydr. Engr., Holyoke Water Power Co., Holyoke, Mass.		Mar. 4, 1903
Simpson, Erastus Roland. 490 North St., Pittsfield, Mass.		Nov. 4, 1903
Simpson, George. Chf. Engr., Thompson-Starrett Co., 51 Wall St., New York City		April 4, 1900
Simpson, Paul Dyer. Sullivan Harbor, Me.		Feb. 6, 1907
Sims, Stuart. Care, Chf. Engr., Nisqually Power Plant, Tacoma, Wash.		July 1, 1909
Sinnickson, George Rosengarten. Penna. R. R. Office, Paoli, Pa.	Jun. Assoc. M.	Sept. 5, 1899 Feb. 6, 1907
Sisson, George Arthur. Junior Engr., U. S. Engr. Dept., Fort Stevens, Ore.	Jun. Assoc. M.	April 30, 1907 Oct. 5, 1909
Sitt, William Theodore. Cons. Engr., Wells Bros. Co. of N. Y., 160 Fifth Ave., New York City		June 7, 1905
Skelly, James William. Asst. Engr., U. S. Engr. Office, Custom House, St. Louis, Mo.	Jun. Assoc. M.	May 2, 1899 April 1, 1903
Skillin, Edward Simeon. Second Vice-Pres., The Snare & Triest Co., 143 Liberty St., New York City		Dec. 1, 1908
Skinner, Frederick Gardiner. 1321 Grant Ave., Denver, Colo.		Sept. 4, 1907
Slayton, Charles Albert. Care, Met. St. Ry. Co., Kansas City, Mo.		April 2, 1902
Slocum, Curlys Lyon. Asst. Engr., New York Extension, P. R. R., 10 Bridge St., Room 910, New York City	Jun. Assoc. M.	Jan. 3, 1905 July 9, 1906
Smiley, Grier Ralston. Res. Engr., Florida East Coast Ry., Key West Extension, Marathon, Fla.		April 1, 1908
Smith, Albert. Civ. and Min. Engr., Saltsburg, Pa.		Jan. 6, 1892
Smith, Albert Henry. Cons. Engr., 322 The Nasby, Toledo, Ohio		Oct. 2, 1901
Smith, Albert Orange. Civ. and Landscape Engr.; Supt. of Highways, Suffolk County, Port Jefferson, N. Y.	Jun. Assoc. M.	May 2, 1905 Feb. 2, 1909
Smith, Charles Bailey. Chf. Engr., Salmon River Canals, Twin Falls Salmon River Land & Water Co., Twin Falls, Idaho		Jan. 3, 1906

		Date of Membership.
SMITH, CHARLES VERNON. Chf. Draftsman, Hudson Companies, 30 Church St., New York City		Dec. 5, 1906
SMITH, CHESTER WASON. Engr., Salt River Project, U. S. Reclamation Service, Roosevelt, Ariz		Oct. 5, 1904
SMITH, COURTLAND ELMORE. Asst. Engr. in Chg., Main Dam, Croton Falls Reservoir, P. O. Box 156, Brewster, N. Y.		Mar. 1, 1905
SMITH, EDGAR FIELD. Asst. Engr. Designer, Board of Water Supply, 299 Broadway, Room 1519 (Res., 524 West 159th St.), New York City		May 1, 1907
SMITH, EDGAR MAVERICK. M. of W. Device & Eng. Co., 9 East 30th St., New York City		Dec. 2, 1903
SMITH, FORREST LEIGH. Township Engr., 102 Smith St., Perth Amboy, N. J.	Jun. Assoc. M.	April 30, 1907 Nov. 8, 1909
SMITH, GEORGE EDSON PHILIP. Irrig. Engr., Univ. of Arizona, Tucson, Ariz	Jun. Assoc. M.	Feb. 3, 1903 Sept. 6, 1905
SMITH, HARRADON STERLING. Cons. Engr. (Smith & Welles), Coal Exchange Bldg., Wilkes-Barre, Pa		Nov. 1, 1905
SMITH, JULIAN CHATARD. Pres. and Mgr., Vacuum Specialty Co., 624 First Ave., New York City		Oct. 2, 1907
SMITH, LAYTON FONTAINE. Engr. Representative, Trussed Concrete Steel Co., Wilson Bldg., Baltimore, Md		June 5, 1907
SMITH, LEONARD SEWALL. Asst. Prof., Topographic and Geodetic Eng., Univ. of Wisconsin, Madison, Wis		June 2, 1897
SMITH, LLOYD BOWN. Engr., The Topeka Bridge & Iron Mfg. Co., Topeka, Kans		April 6, 1904
SMITH, PEMBERTON. South American Representative, U. S. Steel Products Export Co., 544 Bartolomé Mitre, Buenos Aires, Argentine Republic	Jun. Assoc. M.	Mar. 31, 1891 April 4, 1894
SMITH, RUSSELL BIDDLE. Engr., Estates of Long Beach, L. I., 225 Fifth Ave., New York City		May 6, 1908
SMITH, THOMAS ARTHUR. Care, Turner Constr. Co., 11 Broadway, New York City		April 6, 1909
SMITH, TRAVIS LOGAN, JR. Civ. Engr. and Surv., Eagle Lake, Tex	Jun. Assoc. M.	Feb. 3, 1903 Nov. 4, 1908
SMITH, WILLIAM ERNEST. 730 W. Third St., Webb City, Mo		Dec. 1, 1908
SMITH, WILLIAM STUART. Dist. Mgr., Warren Bros. Co., 49 West Ave., Rochester, N. Y		Jan. 8, 1902
SMITH, WILSON FITCH. Div. Engr., Board of Water Supply of City of New York, Valhalla, N. Y.	Jun. Assoc. M.	Jan. 3, 1895 May 1, 1901
SNELL, HARRY BRONSON. 315 Lafayette Ave., Brooklyn, N. Y.		Dec. 5, 1906
SNYDER, CHARLES HERMAN. City Engr., City Hall, Oswego, N. Y.	Jun. Assoc. M.	Oct. 7, 1902 July 9, 1906
SNYDER, FREDERIC ANTES. Secy. and Res. Mgr., Cuban Eng. & Contr. Co., Arsenal 2 (P. O. Box 669), Havana, Cuba		June 1, 1904

		Date of Membership.
Solomon, Gabriel Roberts. (Solomon-Norcross Co., Engrs.), 1622 Candler Bldg., Atlanta, Ga		Oct. 2, 1907
Soper, Ellis Clark. Pres., The Soper Co., 1110 Ford Bldg., Detroit, Mich		Dec 5, 1906
Soper, Ralph Carroll. Asst. Engr., U. S. Reclamation Service, Shoshone Dam, Cody, Wyo		Aug. 31, 1909
Soulé, Edward Lee. Structural Engr. with Jno. B. Leonard, 2330 Durant Ave., Berkeley, Cal	Jun. Assoc. M.	April 3, 1906 Jan. 4, 1910
Souther, Theodore Wheeler. West Point, N. Y		Mar. 6, 1907
Southworth, Edward Augustus. Dept. of Public Works, Honolulu, Hawaii		July 1, 1909
Sparrow, William Warburton Knox. Care, J. A. L. Waddell, 608 New Nelson Bldg., Kansas City, Mo		Dec. 6, 1905
Spear, Philip Hichborn. Asst. Engr., N. Y. C. & H. R. R. R., Raritan, Somerset Co., N. J	Jun. Assoc. M.	Dec. 5, 1905 Feb. 5, 1908
Spearman, Charles. Cons. Hydr. and Irrig. Engr., Room 210, Boise City National Bank Bldg., Boise, Idaho		Oct. 5, 1909
Speicher, Pius Melanthon. Contr., Chandler, Okla		Nov. 7, 1906
Spencer, Herbert. Cons. Engr., Standard Oil Co., Road Oil Dept., 26 Broadway, New York City	Jun. Assoc. M.	Feb. 2, 1904 Mar. 4, 1908
Spencer, Louis Bernard. Civ. and Min. Engr., P. O. Box 499, Ogden, Utah	Jun. Assoc. M.	Oct. 31, 1899 Nov. 8, 1909
Spencer, Theodore Nelson. Asst. Engr. in Chg., Torresdale Filters, 1821 Mt. Vernon St., Philadelphia, Pa		Sept. 5, 1900
Spencer, Walter Tuttle. Div. Engr., N. Y., N. H. & H. R. R., Waterbury, Conn	Jun. Assoc. M.	May 2, 1893 Oct. 4, 1899
Spengler, Albert. Engr. and Supt. for H. S. Crocker, 2626 Holly St., Denver, Colo		May 6, 1908
Spielman, John Godfrey. Illinois Steel Co., 1319 Wabansia Ave., Chicago (Res., 4128 N. Hermitage Ave., Ravenswood), Ill	Jun. Assoc. M.	Mar. 4, 1891 May 1, 1895
Spiker, William Clare. Empire Bldg., Atlanta, Ga		June 5, 1907
Splitstone, Charles Harold. Res. Engr., Erie R. R., 9 Girard Ave., East Orange, N. J	Jun. Assoc. M.	Sept. 5, 1905 Oct. 5, 1909
Sprague, Norman Salisbury. Supt., Bureau of Constr., City Hall, Pittsburg, Pa		July 10, 1907
Stanley, Orrin Elmore. Asst. Engr., O. R. & N. Co., Biggs, Ore		Oct. 7, 1908
Stanton, Fred Caswell. Asst. Engr., Isthmian Canal Comm., Cristobal, Canal Zone, Panama		April 1, 1908
Starr, Herbert Harris. Asst. Engr., Erecting Dept., Am. Bridge Co. of N. Y., 1604 Penna. Bldg., Philadelphia, Pa.		Oct. 2, 1907
Stearns, Edward Burnham. Contr. Mgr., Am. Bridge Co. of N. Y., 141 Milk St., Boston, Mass		June 1, 1898
Stearns, Fred Lincoln. Dist. Supt. of Street Cleaning, Scarsdale, N. Y	Assoc. Assoc. M.	June 3, 1902 Jan. 31, 1905

		Date of Membership.
Stearns, Ralph Hamilton. Asst. Engr. Designer, Board of Water Supply, 299 Broadway, New York City		Dec. 4, 1907
Steere, Anthony Enoch. Asst. Engr., N. Y. State Barge Canal, Fort Hunter, N. Y.		April 1, 1908
Steffens, William Frederick. Engr. of Structures, Boston and Albany R. R., South Station, Boston, Mass	Jun. Assoc. M.	April 3, 1900 Oct. 1, 1902
Stehle, Felix Charles. With Empire Bridge Co. at Brooklyn Plant; Address, 1114 Jackson Ave., Bronx, New York City		June 3, 1903
Stengel, Carl Henry. Pres., The Electrical Alloy Co., Morristown, N. J.		Oct. 3, 1906
Stenger, Ernest. Ray Con. Copper Co., Kelvin, Ariz		June 5, 1895
Stepath, Charles Underhill. Olive Bridge, Ulster Co., N. Y.	Jun. Assoc. M.	Feb. 3, 1903 July 10, 1907
Stephenson, Frank Henry. Res. Engr. for Alvord & Burdick, 326 Parrett St., Evansville, Ind		Jan. 8, 1908
Stephenson, Stuart Augustus, Jr. With J. G. White & Co., Inc., in Chg. of Costs, Conn. River Power Co. Transmission Lines, 68 Central Exchange Bldg., Worcester, Mass.	Jun. Assoc. M.	Jan. 3, 1905 July 10, 1907
Stevens, Alexander. Supt. of Bldgs., N. Y. Fire Dept., 157 East 67th St., New York City		April 1, 1896
Stevens, Elihu William. Engr. for F. R. Long Co., Contrs., Hackensack, N. J.		April 6, 1909
Stevens, George M. 35 Sagamore Ave., Winthrop, Mass.		Nov. 6, 1907
Stevens, Harold Lyell. Pres., H. L. Stevens & Co., 63 North Forsyth St., Atlanta, Ga.		April 6, 1909
Stevens, John Cyprian. 209 Tilford Bldg., Portland, Ore.		April 1, 1908
Stevens, Perley Egbert. Asst. Engr., Bridge Dept., G. N. Ry.; Address, 1753 Marshall Ave., St. Paul, Minn	Jun. Assoc. M.	April 6, 1897 April 2, 1902
Stevenson, Thomas Patton, Jr. Engr. and Contr. (Stevenson & Headman), P. O. Box 1012, Rio de Janeiro, Brazil	Jun. Assoc. M.	April 4, 1905 Nov. 6, 1907
Stevenson, William Freeman. 605 West 178th St., New York City		Oct. 5, 1904
Stevenson, William Lawrie. Asst. Engr., Sewage Dis. Works, Bureau of Surveys, 412 City Hall, Philadelphia, Pa.		Oct. 2, 1907
Stewart, Clinton Brown. Cons. Hydr. Engr., Wisconsin Bldg., Madison, Wis.		Oct. 5, 1898
Stewart, John. Western Mgr. and Mgr., Brick Dept., The Cranford Pav. Co., 2620 E St., N. W., Washington, D. C.		Nov. 4, 1908
Stewart, John Truesdale. Univ. Farm, St. Paul, Minn.		Sept. 6, 1905

		Date of Membership.
Stewart, John Wellington. Care, W. B. Storey, Jr., Vice-Pres., A., T. & S. F. System, 1033 Ry. Exchange, Chicago, Ill		Jan. 2, 1907
Stewart, Spencer James. Div. Engr., Div. No. 1, N. Y. State Highway Comm., Poughkeepsie, N. Y		June 7, 1899
Stidham, Harrison. Secy. and Mgr., Washington Fertilizer Co., Hibbs Bldg., Washington, D. C		April 4, 1900
Stockett, Alfred Walton. Mgr., The Simmer & Jack Proprietary Mines, Ltd., P. O. Box 192, Germiston, Transvaal, South Africa		Jan. 1, 1896
Stockman, Louis Richard. Care, U. S. Reclamation Service, Cody, Wyo		July 9, 1906
Stockton, John. Superv. Engr., Havana Coal Co., San Pedro 2 (altos), Havana, Cuba		Sept. 6, 1905
Stockton, Robert Summers. Engr., U. S. Reclamation Service, La Mesa, Glendive, Mont		April 6, 1909
Stoddard, Raymond French. Engr., Congress Street Bridge Comm., Bridgeport, Conn.; Address, Milford, Conn		Jan. 3, 1906
Stokes, Stanley Frederick. Govt. Engr., Mines Dept., Johannesburg, Transvaal, South Africa		Oct. 4, 1905
Stone, Willard Wilberforce. Asst. Engr., Board of Water Supply, City of New York, Walden, N. Y		Feb. 7, 1906
Storer, Stacy Steward. Designing Engr., Va. Bridge & Iron Co., Roanoke, Va		Nov. 4, 1908
Stout, Homer Harding. 114 North Kedzie Ave., Chicago, Ill		Oct. 7, 1908
Stowitts, George Putnam. Chf. Draftsman, N. Y. C. & H. R. R. R. Co., Room 1136, Grand Central Station (Res., 3168 Decatur Ave.), New York City		June 3, 1908
Strahan, Charles Morton. Prof., Civ. Eng., Univ. of Georgia, Athens, Ga		June 1, 1898
Strathmann, Edward Charles. Gen. Supt., Bedford Stone & Constr. Co., 814 Traction Bldg., Indianapolis, Ind		Nov. 8, 1909
Stratton, George Eber. Engr., U. S. Reclamation Service, Washington, D. C		Jan. 8, 1902
Strawn, Thomas Corwin. 33 Highland Ave., Salem, Ohio	Jun. Assoc. M.	Nov. 5, 1901 June 3, 1903
Strong, Archibald McClure. Min. and Civ. Engr.; County Surv., Inyo County, Bishop, Cal		Jan. 8, 1908
Strong, James Boorman. Asst. Gen. Mgr., Ramapo Iron Works, Hillburn, N. Y		Oct. 5, 1904
Strong, William Edward Schenck. Mgr., Eng. Dept., Am. Radiator Co., Chicago, Ill		April 6, 1898
Stuart, James Lyall. Const. Engr., 341 Sixth Ave., Pittsburg, Pa	Jun. Assoc. M.	Oct. 4, 1898 Feb. 7, 1900
Stubblefield, Garfield. (Whistler & Stubblefield, Civ. and Hydr. Engrs.), Chamber of Commerce Bldg., Portland, Ore.		Nov. 6, 1907

		Date of Membership.
Sudriers, Victor Boureau. Agraciada 633, Montevideo, Uruguay		Oct. 3, 1906
Sullivan, John Francis. Eng. Dept., Public Service Comm., 1st Dist., 601 West 151st St., New York City		Jan. 4, 1910
Sundstrom, Alfred Yngve. Bridge Engr., Mexican Ry., City of Mexico, Mexico		June 6, 1906
Sussex, James Wolfe. Archt. and Engr., Wenatchee, Wash	Jun. Assoc. M.	Oct. 6, 1903 Oct. 2, 1907
Suter, Russell. Asst. Engr., Board of Water Supply, 299 Broadway, New York City		Jan. 2, 1907
Sutton, Charles Wood. Chf. Engr., Hydrologic Comm. of "La Libertad," Trujillo, Peru	Jun. Assoc. M.	Dec. 1, 1903 Dec. 6, 1905
Swartwout, Roy Adolf. Vice-Pres. and Gen. Mgr., Western Bridge & Constr. Co., 340 Bee Bldg., Omaha, Nebr	Jun. Assoc. M.	May 2, 1905 July 1, 1909
Swaty, David Youngs. Asst. Engr., Penn. Lines W. of Pitts., 1116 Union Station, Pittsburg, Pa	Jun. Assoc. M.	Oct. 6, 1903 Oct. 3, 1906
Sweeney, Harry Clinton. 790 President St., Brooklyn, N. Y.		July 1, 1909
Sweitzer, Nelson Bowman. U. S. Examiner of Surveys, Gen. Land Office, Washington, D. C.	Jun. Assoc. M.	Feb. 28, 1893 Mar. 1, 1899
Swickard, Andrew. 225 Adams St., San José, Cal		June 6, 1906
Swift, William Everett. Div. Engr., Hudson River Div., N. Y. Board of Water Supply, Cornwall-on-Hudson, N. Y.		Sept. 2, 1903
Swindells, Joseph Springer. 1090 East 18th St., Brooklyn, N. Y.	Jun. Assoc. M.	Feb. 2, 1897 Mar. 2, 1904
Sykes, George. Bldg. Constr., 1123 Broadway, New York City	Jun. Assoc. M.	May 1, 1906 Dec. 4, 1907
Sykes, George Whitfield. Mercer, Pa	Jun. Assoc. M.	April 30, 1895 Dec. 1, 1897
Sylvester, Albert Hale. Forest Supervisor, Wenatchee National Forest, Leavenworth, Wash		June 7, 1905
Taft, Jesse Russell. 157 West 80th St., New York City	Jun. Assoc. M.	June 2, 1903 Sept. 6, 1905
Taggart, Ralph Cone. World Bldg., New York City		Oct. 5, 1904
Tait, Harold. Bureau of Sewers, Hackett Bldg., Long Island City, N. Y.		May 7, 1902
Tait, John George. 215 West 125th St., New York City		May 6, 1896
Talbot, Earle. 2042 Fifth Ave., New York City	Jun. Assoc. M.	Nov. 1, 1904 Mar. 4, 1908
Tallman, Leroy. Box 67, Portsmouth, R. I.		Feb. 2, 1909
Tarr, Charles Winthrop. Asst. Engr., Dept. of Water Supply, Gas and Electricity, Room 25, Municipal Bldg., Brooklyn, N. Y.		June 6, 1906
Taubenheim, Ulrich. Archangel, Russia		Feb. 1, 1905

		Date of Membership.
Taylor, Alexander Jenifer. Engr. in Chg. of Sewers, Wilmington, Del.	Jun. Assoc. M.	Oct. 3, 1899 April 3, 1907
Taylor, Granville Lewis. Asst. Chf. Engr., McClintic-Marshall Constr. Co., Pittsburg, Pa.		Feb. 2, 1909
Taylor, Jackson, Jr. Asst. Engr., U. S. Coal & Coke Co., Gary, W. Va.		Oct. 7, 1908
Taylor, Norman Alfred. Asst. Engr., Dept. of Highways, Albany, N. Y.	Jun. Assoc. M.	Oct. 6, 1903 Dec. 5, 1906
Taylor, Oliver Kirk, Jr. City Engr. and Surv., 767 East Maiden St., Washington, Pa.		May 6, 1908
Taylor, Robert William, Jr. Mgr., Luzerne Eng. Co., 15 East Broad St., Hazleton, Pa.		June 6, 1906
Taylor, William Purves. Engr. in Chg. of Philadelphia Municipal Testing Laboratories, 318 City Hall, Philadelphia, Pa.	Jun. Assoc. M.	Oct. 7, 1902 May 4, 1909
Tebbetts, George Edward. 209 Adams St., Room 62, Chicago, Ill.		Jan. 4, 1910
Teigen, Thomas William Rostad. Locating Engr., Mexico-Northwestern Ry., Madera, Chihuahua, Mexico	Jun. Assoc. M.	Sept. 5, 1905 Dec. 1, 1908
Terry, Alfred Howe. N. Y., N. H. & H. R. R., New Haven, Conn.		June 6, 1906
Thanheiser, Charles August. Asst. Supt., T. & N. O. R. R., Houston, Tex.		July 10, 1907
Thayer, Horace Richmond. Asst. Prof. of Structural Design, Carnegie Technical Schools, 712 S. Linden Ave., Pittsburg, Pa.		Mar. 7, 1906
Theban, John Gerard. Engr. in Chg. of Dept. of Bridges, Borough of the Bronx, 428 East 133d St., New York City		Mar. 3, 1897
Theodorson, William Anton. With Terminal Engr., C. & N. W. Ry., Jackson Boulevard and Franklin St., Chicago, Ill.		Oct. 7, 1908
Thoma, Jacob. Bureau of Sewers, Hackett Bldg., Long Island City, N. Y.		Oct. 7, 1908
Thomas, Charles Dura. Asst. Engr., Public Service Comm. for the First Dist., 154 Nassau St., New York City (Res., 547 Carlton Ave., Brooklyn, N. Y.)		Jan. 8, 1908
Thomas, Edgar Branson. Chf. Draftsman, Office of City Civ. Engr. (Res. 11417 Glenwood Ave., S. E.), Cleveland Ohio		June 3, 1908
Thomas, Ralph Danford. Asst. Engr., Minneapolis Mill Co., Minneapolis, Minn.		May 6, 1908
Thomas, Samuel Richards. Supt. and Engr., Ironton R. R., Hokendauqua, Pa.	Jun. Assoc. M.	Oct. 4, 1892 Mar. 1, 1899
Thomas, William Edward. Asst. Engr., L. I. R. R., Colonial Hall, Jamaica, N. Y.		July 1, 1909

		Date of Membership
Thomas, William Michael. Bridge Engr., 1012 Union Trust Bldg., Los Angeles, Cal		Nov. 8, 1909
Thomes, Edwin Howard. Asst. Engr., Bureau of Highways, Queens Borough, New York City; Res., 161 Willett St., Jamaica, N. Y		Dec. 6, 1899
Thompson, Arthur Webster. Chf. Engr., M. of W., B. & O. R. R. Co., Baltimore, Md		June 4, 1902
Thompson, Clarence Hard. Structural Engr., The Solvay Process Co., 209½ Sabine St., Syracuse, N. Y		Sept. 7, 1904
Thompson, Clark Wallace. Vice-Pres., Wind River Lumber Co., Cascade Locks, Ore	Jun. Assoc. M.	Mar. 5, 1890 July 3, 1895
Thompson, Mackey James. 514 Pioneer Press Bldg., St. Paul, Minn		Oct. 7, 1903
Thompson, Robert Andrew. Chf. Engr., Wichita Falls & Northwestern Ry., Wichita Falls, Tex	Jun. Assoc. M.	April 6, 1897 Oct. 4, 1899
Thomson, Alexander, Jr. Div. Engr., Board of Water Supply, Walden, Orange Co., N. Y	Jun. Assoc. M.	Dec. 4, 1900 Feb. 3, 1904
Thomson, Samuel Forsythe. Asst. Engr., Board of Water Supply of New York City, New Paltz, Ulster Co., N. Y		Jan. 3, 1906
Thorn, Columbus William. Asst. Engr., Constr., P. R. R., Camden Terminal, Camden, N. J		July 9, 1906
Thrane, Martin Mathias. Engr., Bldg. Dept., Gen. Elec. Co., Pittsfield, Mass		Jan. 8, 1908
Throop, Augustus Thompson. Res. Engr., Utica Gas & Elec. Co., Little Falls, N. Y	Jun. Assoc. M.	Oct. 3, 1893 Mar. 3, 1897
Throop, George Huntington. Care, J. G. White & Co., 43 Exchange Pl., New York City		May 1, 1907
Thurber, Clinton Draper. Asst. Civ. Engr., U. S. N., Navy Yard, Norfolk, Va		Oct. 4, 1905
Thuringer, Charles. Asst. Div. Engr., Div. of Subways and Tunnels, Board of Superv. Engrs., 181 La Salle St. (Res., 4860 Winthrop Ave.), Chicago, Ill		Mar. 4, 1908
Thurston, Eugene True, Jr. (Couchot & Thurston, Engrs. and Gen. Contrs.), Wells Fargo Bldg., San Francisco, Cal.		Mar. 6, 1907
Tibbetts, Frank Leslie. Asst. Engr., East Boston Co., 19 Congress St., Boston, Mass		Jan. 4, 1910
Tibbetts, Frederick Horace. Structural and Hydr. Engr.; Asst. Prof., Civ. Eng., Univ. of California, Berkeley, Cal	Jun. Assoc. M.	May 1, 1906 April 6, 1909
Tidd, Arthur Warren. Asst. Engr., Board of Water Supply, New York City, So. Aque. Dept., White Plains, N. Y		June 3, 1903
Tiffany, Nelson Otis, Jr. Engr. and Contr. (Tiffany & Gail), 1010 Mutual Life Bldg., Buffalo, N. Y		Jan. 2, 1907

		Date of Membership.
Tilden, Charles Joseph. Junior Prof. of Civ. Eng., Univ. of Michigan, 1619 Israel Ave., Ann Arbor, Mich	Jun. Assoc. M.	May 31, 1898 Feb. 5, 1902
Tillinghast, Frederick Howard. Orland, Glenn Co., Cal		May 1, 1907
Tilmont, Paul Alphonse Gaillard. Res. Engr., N. P. Ry., Chehalis, Wash		July 1, 1909
Tilt, Garret Edward. Chf. Engr., Structural Dept., Care, John Monks & Sons, 82 Beaver St., New York City		June 1, 1909
Titsworth, Ralph Bentley. 452 W. 5th St., Plainfield, N. J		Dec. 1, 1908
Toltz, Max. Gen. Mgr., Manistee & Grand Rapids R. R., 702 Manhattan Bldg., St. Paul, Minn		Sept. 7, 1892
Tönnesen, Fridthjov Lauritz Martin. Dist. Engr., Cuba R. R. Co., Palma Soriano, Cuba		June 3, 1908
Tooker, Francis Westervelt. Landscape Archt. and Engr. (Hinchman, Pilat & Tooker), 52 Broadway, New York City		Dec. 6, 1905
Torre, Alberto de la. Res. Engr., The Colombian National Ry. Co., Ltd. (Ferrocarril de Girardot), Girardot, Colombia		Oct. 3, 1906
Torrey, James Eaton. 369 East 30th St., Paterson, N. J		May 3, 1905
Tower, James Wallace. Prin. Asst. Engr., Great Northern Paper Co., Millinocket, Me		Oct. 2, 1901
Tracy, Louis Downer. Civ. and Min. Engr., 245 Fourth Ave., Pittsburg (Res., 108 Lincoln Ave., Edgewood Park, Allegheny Co.), Pa		Oct. 3, 1906
Tratman, Edward Ernest Russell. 1636 Monadnock Blk., Chicago, Ill	Jun. Assoc. M.	April 7, 1886 July 1, 1891
Travell, Warren Bertram. Engr. and Contr., 816 Third Pl., Plainfield, N. J	Jun. Assoc. M.	April 30, 1895 Mar. 5, 1902
Treadway, Howard Platt. Vice-Pres. and Treas., Kansas City Bridge Co., 45 Water Works Bldg., Kansas City, Mo.		May 6, 1903
Trow, Frank Hamant. Chf. Engr. for MacArthur Bros. Co. and Winston & Co., Contrs., Brown Station, N. Y		Feb. 7, 1906
Tucker, Herman Franklin. Designing Engr., Dept. of Locks and Dam Constr., Isthmian Canal Comm., Culebra, Canal Zone, Panama		Dec. 7, 1904
Tudbury, Warren Chamberlain. Asst. Engr., N. Y. C. & H. R. R. R. Co., 145 Washington St., Buffalo, N. Y		June 1, 1909
Tudor, Clinton Gambrill. U. S. Surv.-General's Office (P. O. Box 862), Reno, Nev		May 1, 1907
Tull, Richard William. Asst. Engr., Eastern Steel Co., 71 Broadway, New York City		May 3, 1905
Tunstall, Whitmell Pugh. Board of Superv. Engrs., Chicago Traction, 181 La Salle St., Chicago, Ill	Jun. Assoc. M.	Oct. 6, 1903 Nov. 4, 1908

		Date of Membership.
TURLEY, OMNER JAY. Box 151, Aztec, N. Mex.		April 6, 1909
TURNEAURE, FREDERICK EUGENE. Dean, Coll. of Eng., Univ. of Wisconsin, Madison, Wis.	Assoc. Assoc. M.	Aug. 31, 1897 June 4, 1902
TURNER, AUGUSTUS MIESSE. Ashville, St. Clair Co., R. F. D. 3, Ala.		Dec. 1, 1908
TURNER, FRANKLIN PIERCE. Asst. Engr., N. & W. Ry. Co., Chillicothe, Ohio (Res., Christiansburg, Va.)		May 6, 1908
TURNER, GEORGE DALLAS BAIRD. Cons. Engr., 17 Battery Pl., New York City (Res., 31 Hampton Terrace, East Orange, N. J.)		Nov. 2, 1898
TURNER, HENRY CHANDLEE. Pres., Turner Constr. Co., 11 Broadway, New York City		April 4, 1906
TURNER, NATHANIEL PARKER. Care, Juragua Iron Co., Firmeza, Santiago, Cuba		Dec. 1, 1908
TURNER, WILLIS TUBBS. Director, Irrig. Work, Cuerpo de Ingenieros de Minas del Peru, Apartado 889, Lima, Peru.		Dec. 7, 1904
TURNEY, OMAR ASA. City Engr., Phœnix, Ariz.		May 6, 1908
TWIGGS, JOHN DAVID, JR. Supt., Canal and Water-Works, Augusta, Ga.		Nov. 1, 1905
TYLER, ROY DEXTER. Greeley, Colo.		Mar. 6, 1907
TYRRELL, WARREN AYRES. Secy. and Treas., Markmann-Tyrrell Eng. Co., 620 Chestnut St., St. Louis, Mo.	Jun. Assoc. M.	Oct. 2, 1900 Oct. 1, 1902
UHLER, WILLIAM DAVID. Asst. Chf. Engr., State Roads Comm., Care, Johns Hopkins Univ., Baltimore, Md.		May 6, 1908
ULRICH, DANIEL. Katonah, Westchester Co., N. Y.		Sept. 1, 1897
ULRICH, EDMUND BOYD. City Engr. and Chf. Commr., Highways and Sewers, Reading, Pa.		April 6, 1909
UNDERHILL, GRANDISON GRIDLEY. Asst. Engr., N. Y. State Barge Canal, Albany, N. Y.		June 5, 1907
UNDERWOOD, HOWARD WARREN. (Field, Barker & Underwood, Inc., Engrs. and Contrs.), 718 Arcade Bldg., Philadelphia, Pa.	Jun. Assoc. M.	Dec. 3, 1901 April 3, 1907
UNGER, ERIK BIRGER LUND. Asst. Engr., Mexican Ry. Co., City of Mexico, Mexico		Nov. 8, 1909
UPHAM, RICHARD DANA. 11 Broadway, New York City	Assoc. Assoc. M.	Oct. 6, 1896 April 3, 1901
UPSON, MAXWELL MAYHEW. Secy. and Gen. Mgr., Raymond Concrete Pile Co., 140 Cedar St., New York City		May 6, 1908
URQUHART, GEORGE COPELAND. Real Estate Agt., Penn. Lines W. of Pitts., 1104 Union Station Bldg., Pittsburg, Pa.		May 6, 1891
VAIL, JOHN JERVIS. Constr. Dept., P. R. R. (Res., 59 Hazlewood Ave.), Rahway, N. J.		Jan. 4, 1905
VALLE ZENO, CARLOS DEL. P. O. Box 1037, Havana, Cuba		April 1, 1908

		Date of Membership.
Van Buskirk, Clarence Randall. Archt. and Civ. Engr., 2942 West 8th St. (Res., 108 Van Sicklen St.), Brooklyn, N. Y.		Feb. 3, 1897
Vance, Alexander Milton. Asst. Engr., Mo. Pac. Ry., Seventh and Poplar Sts., St. Louis, Mo		Nov. 7, 1906
Van Etten, Lawrence Edward. New Rochelle, N. Y.		Dec. 6, 1899
Van Liew, John Edgar. Contr. Engr., Des Moines Bridge & Iron Works (Res., 1306 E. Grand Ave.), Des Moines, Iowa		July 1, 1908
Van Loan, Seth Morton. First Asst. Engr., Water Bureau, Room 790, City Hall, Philadelphia, Pa.	Jun. Assoc. M.	Dec. 28, 1900 Oct. 7, 1903
Vanneman, Charles Reeve. 436 Hudson Ave., Albany, N. Y.		June 3, 1908
Van Ness, Howard Edward. Asst. Engr., C. R. R. Co. of N. J., Little Falls, N. J.		Dec. 4, 1907
Van Ornum, Samuel Judson. City Engr., Pasadena, Cal.		Dec. 4, 1907
Van Pelt, Sutton. Gen. Mgr. of Constr., Am. Asphaltum & Rubber Co., 601 Harvester Bldg., Chicago, Ill.	Jun. Assoc. M.	Mar. 6, 1900 Dec. 2, 1903
Van Suetendael, Achille Octave. Structural Engr., State Archt.'s Office, Albany, N. Y.	Jun. Assoc. M.	Jan. 3, 1905 June 3, 1908
Vedeler, Gerdt Henrik. Cons. Engr., Prinsens Gd. 22, Christiania, Norway		June 7, 1893
Vehrenkamp, Henry William. Chf. Engr. of the Ferro Concrete Constr. Co., 3113 Murdock Ave., Cincinnati, Ohio.		June 5, 1907
Vernon, Stephen Barker. Syracuse Intercepting Sewer Board, 112 Court House, Syracuse, N. Y.		Jan. 4, 1910
Verveer, Emanuel Louis. Structural Engr., 507 West 112th St., New York City		June 3, 1903
Vickers, Thomas McElderry. Mgr., Waldorf Mfg. Co., Auburn, N. Y.		Mar. 2, 1898
Vier, Henry. Engr. of Resurveys, N. Y. C. & H. R. R. R. Co., Room 1120, Grand Central Station, New York City		Feb. 7, 1900
Villalon, José Ramon. Calle de Cuba No. 37, Havana, Cuba	Jun. Assoc. M.	July 4, 1888 Nov. 6, 1895
Vinton, Thomas MacIntire. Pres., Tucker & Vinton, Terminal Bldg., 41st St. and Park Ave., New York City		Feb. 3, 1904
Vliegenthart, Johannes Cornelis. Engr., Hai-ho River Conservancy, Tientsin, North China		June 5, 1907
Vogt, John Henry Leon. Secy. and Treas., Associated Eng. Co., 112 W. Jefferson St., Louisville, Ky.		April 6, 1909
von Unwerth, Hans. Cons. Engr., 722 Dwight Bldg., Kansas City, Mo		May 6, 1903
Voorhees, Paul. Asst. Engr., P. & R. Ry. Co. (Res., 2229 Fourth St.), Harrisburg, Pa.		Feb. 3, 1892

		Date of Membership.
Voynow, Constantine Borisson. Asst. Engr., Phil. Rap. Trans. Co., 9th and Dauphin Sts., Philadelphia, Pa.		Sept. 7, 1904
Vredenburgh, Watson, Jr. Cons. and Insp. Engr. (Hildreth & Co.), 135 Broadway, New York City		Mar. 6, 1901
Vrooman, Morrell. City Engr., Gloversville, N. Y.		May 7, 1902
Wachter, Charles Lucas. Engr., Lidgerwood Mfg. Co., 96 Liberty St., New York City	Jun. Assoc. M.	June 3, 1902 Oct. 5, 1904
Wada, Yoshichika. Shimamura, Sabagun, Gunbaken, Japan	Jun. Assoc. M.	Sept. 7, 1887 Oct. 2, 1895
Waddell, Frederick Creelman. Structural Engr. with Hudson Structural Steel Co., 136th St. & Southern Blvd., New York City		Oct. 4, 1905
Wagner, Fred J. First Res. Engr., Dept. of State Engr. and Surv., Syracuse, N. Y.		April 4, 1906
Wagner, Harry Edward. Res. Engr., D., L. & W. R. R., Andover, N. J.		Nov. 6, 1907
Wait, Owen Adelbert. 215 Fifth St., Niagara Falls, N. Y.		Dec. 6, 1905
Waldron, Albert Edwin. Capt., Corps of Engrs., U. S. A., U. S. Engr. Office, Dallas, Tex.		July 1, 1909
Walker, Edward Lloyd. Gen. Insp., Chf. Engr.'s Office, Aqueduct Comm., 280 Broadway, Room 213, New York City	Jun. Assoc. M.	Feb. 3, 1903 Oct. 3, 1906
Walker, Edward Mansfield. Detroit River Tunnel Co., 489 Fort St., West, Detroit, Mich.		Nov. 8, 1909
Walker, Joseph Jeanes. Dobbs Ferry, N. Y.		Nov. 5, 1902
Wallace, William McGehee. 2028 F St., N. W., Washington, D. C.	Jun. Assoc. M.	April 3, 1894 Nov. 6, 1901
Walling, Victor Roy. Supt., Cananea Consolidated Copper Co.'s Ry., Cananea, Sonora, Mexico		June 6, 1906
Walter, George Shirley. Care, Hotchkiss Contr. Co., 1210 Manhattan Bldg., Chicago, Ill.		Jan. 5, 1909
Walters, Henry Radclyffe St. Arvans. Supt. of Bridge Shop, Bethlehem Steel Co. (Res., 228 Wall St.), Bethlehem, Pa.	Jun. Assoc. M.	Oct. 6, 1903 April 5, 1905
Walther, Edward. 1421 Humboldt Boulevard, Chicago, Ill.		May 1, 1895
Waltman, William DeWitt. Res Engr., The Costilla Estates Development Co., San Luis, Colo.		Dec. 1, 1908
Ward, Charles Clarence. City Engr., P. O. Box 407, Wenatchee, Wash.		July 10, 1907
Wardle, Edward Beaumont. Engr. for Geo. F. Hardy, 309 Broadway, Room 608, New York City		Dec. 4, 1907
Ware, John. Asst. Engr., Cambridge Main St. Subway, Bost. Elev. Ry., 18 Ash St., Cambridge, Mass.		July 9, 1906
Warren, Herbert Anson. Contr. Mgr., Am. Bridge Co. of N. Y., 30 Church St., New York City		Sept. 5, 1906

		Date of Membership.
WASHINGTON, WILLIAM DE HERTBURNE. 267 Fifth Ave., New York City		Oct. 5, 1892
WASSER, THOMAS JAMES. 1 Montgomery St., Jersey City, N. J		April 3, 1907
WASSNER, MICHAEL. Care, Mo. Pac. Ry., 1101 Buena Ave., Chicago, Ill		June 5, 1907
WATANABE, EITARO. Imperial Taiwan Rys., Takow, Formosa, Japan		April 5, 1905
WATKINS, GUY ANDERSON. (Dickinson, Kingsley & Watkins), Southern Trust Bldg., Little Rock, Ark	Jun. Assoc. M.	Jan. 3, 1907 Nov. 8, 1909
WATSON, WALTER. Salem, Va		April 5, 1893
WAUGH, WILLIAM HAMMOND. Acting Div. Engr., Bureau of Public Works, Manila, Philippine Islands	Jun. Assoc. M.	Oct. 1, 1901 June 5, 1907
WEBBER, CHARLES PERKINS. Chf. Engr., Ferrocarril de Veracruz al Istmo, Apartado 106, Vera Cruz, V. C., Mexico		Oct. 7, 1908
WEBBER, ROY IRVIN. Associate Prof., Structural Eng., The Pennsylvania State Coll., State College, Pa		April 1, 1908
WEBSTER, FRANK WALLACE. Constr. Supt. for Raymond Concrete Pile Co., 135 Adams St., Chicago, Ill		May 6, 1908
WEDGEWORTH, DONALD CLARK. Asst. Engr., Dept. of State Engr., Barge Canal Office, Baldwinsville, N. Y		April 1, 1908
WEIDEL, JOSEPH. Asst. Engr., A., T. & S. F. Ry., 913 Clay St., Topeka, Kans		July 10, 1907
WEILAND, ADELBERT ALONZO. 1506 Carterett Ave., Pueblo, Colo.		April 6, 1909
WEISS, ANDREW. Project Engr., U. S. Reclamation Service, Mitchell, Nebr		Jan. 8, 1908
WELLER, FRANCIS REPETTI. Civ. and Hydr. Engr., Hibbs Bldg., Washington, D. C	Jun. Assoc. M.	Feb. 5, 1901 Nov. 1, 1905
WELLES, EARLE HUBBEL. Address unknown		Feb. 7, 1906
WELLS, GEORGE MILLER. Office Engr., Atlantic Div., Gatun, Canal Zone, Panama		Oct. 3, 1906
WELTON, BENJAMIN FRANKLIN. Examining Engr., Commrs. of Accounts, 280 Broadway, New York City (Res., 1 Wiener Pl., Tompkinsville, N. Y.)	Jun. Assoc. M.	April 6, 1897 Nov. 1, 1905
WENIGE, ARTHUR EMIL. Asst. Engr., Dept. of Water Supply, Borough of Richmond, Borough Hall, New Brighton, N. Y	Jun. Assoc. M.	May 6, 1902 Oct. 7, 1908
WENTWORTH, CHARLES AUSTIN. Cons. Engr., with A. L. Register & Co., Canon City, Colo		Oct. 7, 1903
WESCOTT, JAY VARNUM. 1775 Old Colony Bldg., Chicago, Ill		Nov. 30, 1909
WEST, OSCAR JAMES. Res. Engr., Phœnix Bridge Co., 453 The Rookery, Chicago, Ill		May 4, 1904

		Date of Membership.
Weston, Robert Spurr. San. Engr., 14 Beacon St., Boston, Mass.		Feb. 5, 1902
Wheaton, Walter Robert. 342 Citizens National Bank Bldg., Los Angeles, Cal.		Feb. 2, 1909
Wheeler, Arthur Chambers. U. S. Engr. Office, Honolulu, Hawaii		Oct. 7, 1908
Wheeler, Harry Roberts. 17 Battery Pl., New York City	Jun. Assoc. M.	April 4, 1888 May 4, 1892
Wheeler, Ralph Norman. Div. Engr., N. Y. Board of Water Supply, 236 Main St., Poughkeepsie, N. Y.		Jan. 7, 1903
Whiskeman, James Peter. 139 Barry Ave., Mamaroneck, N. Y.	Jun. Assoc. M.	Jan. 31, 1899 Nov. 7, 1900
White, Arthur Burr. (Bixby & White, Civ. and Hydr. Engrs.), 502 Mason Bldg., Los Angeles, Cal.		Nov. 7, 1906
White, Byron Ellsworth. Care, Seminole Land & Investment Co., St. Cloud, Fla.	Jun. Assoc. M.	Oct. 2, 1906 July 1, 1908
White, David Miller. Cons. Civ. Engr.; Chf. Engr., Red Bluff Irrig. Co., P. O. Box 278, Midland, Tex.		Nov. 8, 1909
White, Frank George. Asst. Engr., Office of City Engr., Hewes Bldg., San Francisco, Cal.	Jun. Assoc. M.	Dec. 3, 1901 Dec. 7, 1904
White, Gilbert Case. Cons. Civ. and Hydr. Engr., Durham, N. C.		April 5, 1905
White, Lazarus. Div. Engr., Board of Water Supply, City of New York, High Falls, N. Y.	Jun. Assoc. M.	May 1, 1900 Feb. 4, 1903
White, Willard Olney. Chf. Engr., Tower-Hill Connellsville Coke Co., Republic, Pa.		April 3, 1907
Whited, Willis. Asst. Engr., Dept. of Public Works, City Hall, Pittsburg, Pa.		Oct. 2, 1901
Whitford, Noble Earl. Res. Engr., Dept. of State Engr., State Hall, Albany, N. Y.		Feb. 1, 1905
Whiting, George William Carlyle. Asst. Engr., Baltimore Sewerage Comm., 112 E. Preston St., Baltimore, Md.	Jun. Assoc. M.	Sept. 5, 1905 Nov. 8, 1909
Whitman, Ezra Bailey. Div. Engr., Disposal Works, Sewerage Comm., Back River Sewage Disposal Works, Colgate, Baltimore Co., Md.	Jun. Assoc. M.	Feb. 3, 1903 Feb. 7, 1906
Whitman, Nathan Davis. Engr., Reinforced Concrete Pipe Co., 716 Central Bldg., Los Angeles, Cal.		Dec. 5, 1906
Whitman, Ralph. Asst. Civ. Engr., U. S. N., Bureau of Yards and Docks, Navy Dept., Washington, D. C.		Nov 6, 1907
Whitney, Thomas Bryan, Jr. Engr. of Design, Hudson & Manhattan R. R. Co., 30 Church St., New York City	Jun. Assoc. M.	Sept. 6, 1898 Feb. 6, 1907
Whitson, Abraham Underhill. Asst. Engr., Board of Water Supply, Cold Spring, N. Y.	Jun. Assoc. M.	Jan. 7, 1902 Dec. 5, 1906

		Date of Membership.
Whitted, Levi Romulus. Supt. of Constr., U. S. Public Bldgs., Treasury Dept., New P. O. Bldg., St. Louis, Mo	Jun. Assoc. M.	Mar. 6, 1900 July 9, 1906
Wickersham, John Hough. Lancaster, Pa	Jun. Assoc. M.	May 6, 1902 April 6, 1909
Wickes, Joseph Lee. Commr. of Street Cleaning, City Hall, Baltimore, Md		Mar. 2, 1904
Widdicombe, Robert Alexander. Vice-Pres. and Mgr., Dixon Co., 5552 Lakewood Ave., Edgewater Station, Chicago, Ill	Jun. Assoc. M.	April 2, 1901 Dec. 6, 1905
Wiggin, Ernest Woodbury. Engr., Central New England Ry. Co., Hartford (Res., 48 Third St., New Haven), Conn	Jun. Assoc. M.	May 5, 1896 May 7, 1902
Wiggin, Thomas Hollis. Senior Designing Engr., Board of Water Supply, 299 Broadway, New York City		April 2, 1902
Wiggins, Ralph Raymond. Asst. Engr., Office of Chairman and Chf. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama		Oct. 5, 1909
Wiggins, William D. Engr., M. of W., Pittsburg Div., Pitts., Cin., Chic. & St. L. Ry., 1013 Penn Ave., Pittsburg, Pa.		Oct. 2, 1901
Wilcock, Frederick. 4 Court Sq., Brooklyn, N. Y.	Jun. Assoc. Assoc. M.	Jan. 7, 1902 Oct. 6, 1903 Jan. 4, 1910
Wilcox, Frank Leslie. Hydr. and San. Engr., Security Bldg., St. Louis, Mo	Jun. Assoc. M.	Sept. 6, 1904 Feb. 1, 1910
Wilcox, Fred Elmer. 956 Orange Grove Boulevard, Pasadena, Cal		April 1, 1896
Wild, Herbert Joseph. Res. Engr., Holter Dam, Care, Stone & Webster Engr. Corporation, Holter, Mont	Jun. Assoc. M.	Mar. 31, 1903 April 6, 1904
Wildes, Waldo Gilman. Asst. Engr., Barge Canal Office, Bureau of Water Supply, Rome, N. Y.	Jun. Assoc. M.	Feb. 3, 1903 Jan. 2, 1907
Wilgus, Herbert Sedgwick. Engr., M. of W., P., S. & N. R. R., Angelica, N. Y.	Jun. Assoc. Assoc. M.	Oct. 1, 1901 Nov. 3, 1903 Nov. 1, 1904
Wilhelm, Jerome Frederick. Care, Missouri Val. Bridge & Iron Co., Rob Roy, Ark	Jun. Assoc. M.	Jan. 2, 1900 Mar. 7, 1906
Wilkerson, Thomas Jefferson. Asst. Engr.-Bridge Designer, Bureau of Constr., Dept. of Public Works, 803 Park Bldg., Pittsburg, Pa	Jun. Assoc. M.	April 3, 1894 Jan. 5, 1898
Wilkins, George Shreve. Dept. of Highways, 4179 Third Ave., New York City	Jun. Assoc. M.	Oct. 4, 1892 Oct. 5, 1898
Willard, Norman Rand. 2277 Massachusetts Ave., No. Cambridge, Mass		June 1, 1909

		Date of Membership.
Williams, Howard Shay. 1896 E. 84th St., Cleveland, Ohio	Jun. Assoc. M.	Dec. 1, 1903 June 5, 1907
Williams, Jacob Paul Jones. Asst. Engr. Designer, McClintic-Marshall Constr. Co., 10 Trenton Ave., Swissvale, Pa.		July 1, 1909
Williams, Lester Dennison. Pres., Hirschberg-Williams-Washburn Co., Milwaukee, Wis.		Nov. 8, 1909
Williams, Parley Lycurgus, Jr. Care, Daly West Mining Co., 163 Main St., Salt Lake City, Utah		Sept. 7, 1904
Williams, Roger Butler, Jr. Financial Dept., J. G. White & Co., 43 Exchange Pl., New York City	Jun. Assoc. M.	Oct. 1, 1901 Mar. 7, 1906
Williams, Samuel Walter. 1035 Security Bldg., Los Angeles, Cal.		Feb. 7, 1906
Williams, Walter Scott. Asst. Prof., Civ. Eng., Univ. of Missouri, 818 Virginia Ave., Columbia, Mo.		April 6, 1904
Williamson, Charles Sumner. Contr. Engr., Heyl & Patterson, Inc., Pittsburg, Pa.		Feb. 7, 1906
Willis, Harry Parsons. Waterford, Saratoga Co., N. Y.		Mar. 6, 1907
Wills, Arthur John. 1643 South 54th St., Philadelphia, Pa.		May 7, 1902
Wilson, Harry Percival. Care, Eastern Concrete Constr. Co., 101 Tremont St., Boston, Mass.	Jun. Assoc. M.	Nov. 5, 1907 Oct. 5, 1909
Wilson, James Bean. Supt., The Cabrera Mines, Hostotipaquillo, Jalisco, Mexico		May 2, 1906
Wilson, Phillip Lindsley. Div. Engr., F. E. C. Ry., Marathon, Fla.		July 1, 1908
Wilson, Thad Loren. Asst. Engr., Sewer Div., Rap. Trans. Comm., 1532 Bedford Ave., Brooklyn, N. Y.		July 10, 1907
Wilson, Thomas William. 548 Franklin St., Buffalo, N. Y.		April 4, 1900
Wilson, Wilbur Thomas. 523 West 121st St., New York City		July 1, 1908
Wilson, William Edward. Secy., Am. Section, International Waterways Comm., 328 Federal Bldg., Buffalo, N. Y.	Jun. Assoc. M.	Jan. 6, 1903 June 7, 1905
Wiltsee, William Pharo. Asst. Engr., Norfolk & West. Ry. Co., Roanoke, Va.		Oct. 7, 1903
Winchester, Philip Harold. Div. Engr., N. Y. C. & H. R. R. R., Watertown, N. Y.	Jun. Assoc. M.	Jan. 7, 1902 Feb. 5, 1908
Winfree, Peyton Brown. Asst. Mgr., The Glamorgan Pipe & Foundry Co., Lynchburg, Va.	Jun. Assoc. M.	Oct. 2, 1894 May 3, 1898
Wing, Frederick Kelly. Civ. and Cons. Engr., 910 White Bldg., Buffalo, N. Y.	Jun. Assoc. M.	May 31, 1892 Nov. 1, 1899
Winn, Walter Scott. U. S. Asst. Engr., Kingman, Ala.		Oct. 6, 1897
Winslow, Arthur Ellsworth. Prof., Civ. Eng., Norwich Univ., Northfield, Vt.		June 6, 1906
Winterhalter, Leo P. 70 N. Prospect St., Akron, Ohio		July 1, 1909

		Date of Membership.
Wise, James Hugh. Civ. and Hydr. Engr., Pacific Gas & Elec. Co., 925 Franklin St., San Francisco, Cal.		Feb. 6, 1907
Witham, Myron Ellis. 709 Ideal Bldg., Denver, Colo.		Aug. 31, 1909
Witherell, Frederick Whitefield. (Geo. S. Baton & Co., Civ. and Min. Engrs.), Keystone Bldg., Pittsburg, Pa.	Jun.	Oct. 6, 1903
	Assoc. M.	July 9, 1906
Wolcott, Christopher Stanton. Box 198, Andover, N. J.		June 5, 1907
Wolff, Hans Hermann. Dist. Engr., C., M. & P. S. Ry., Enumclaw, Wash.		Jan. 8, 1908
Wonson, Samuel Lamson. Asst. Engr., Mexican Ry., City of Mexico, D. F., Mexico.		Oct. 5, 1909
Wood, Dethic Hewitt. Chf. Engr., Converse Bridge Co., 101 Chamberlain Ave., Chattanooga, Tenn.		Feb. 6, 1907
Wood, George. 122 West 167th St., High Bridge, New York City.		June 5, 1907
Wood, George Roy. Cons. Elec. Engr., 1207 Park Bldg., Pittsburg, Pa.		April 4, 1906
Wood, Robert Walter. Asst. Engr. in Chg. of Port Richmond Div., Borough of Richmond, New York City, 13 Van Pelt Ave., Mariner Harbor, N. Y.	Jun.	April 30, 1907
	Assoc. M.	Nov. 8, 1909
Wood, Winthrop Barrett. Civ. and Mech. Engr. for The Wanskuck Co., 725 Branch Ave., Providence, R. I.		April 6, 1904
Woodard, Wilkie. Care, City Engr., Los Angeles, Cal.		May 4, 1904
Woodcock, Henry Wright. Civ. Engr. and Surv., 261 Fifty-second St., Brooklyn, N. Y.	Jun.	Dec. 1, 1903
	Assoc. M.	Dec. 4, 1907
Woodle, Allan Sheldon, Jr. Care, The Standard Steel Works Co., Burnham, Pa.		July 9, 1906
Woods, Andrew Alfred. Res. Engr., Alabama & Vicksburg Ry., and Vicksburg, Shreveport & Pacific Ry., Vicksburg, Miss.		May 4, 1904
Woodward, Edwin Carlton. Paving Engr., 1400 Cooper St., Fort Worth, Tex.		Oct. 4, 1905
Worley, John Stephen. 206 Reliance Bldg., Kansas City, Mo.		June 5, 1907
Wortendyke, Nicholas Doremus. Asst. Chf. Engr., Board of Street and Water Commrs., City Hall (Res., 108 Bentley Ave.), Jersey City, N. J.		Feb. 1, 1899
Wortham, John Root. 225 Coronado Blk., Greeley, Colo.	Jun.	Oct. 31, 1905
	Assoc. M.	Oct. 7, 1908
Wright, John Bertram. Deputy Div. Engr., 2d Div., New York State Highway Comm., 8 McClellan Ave., Amsterdam, N. Y.		May 1, 1907
Wrigley, Harry Blakemore. Mech. Engr., Dodge Mfg. Co., 815 Arch St., Philadelphia, Pa.		Nov. 6, 1907

		Date of Membership.
Wyman, Alfred Marshall. Asst. Engr., Public-Service Comm., 1st Dist., 154 Nassau St., New York City (Res., 109 North 16th St., East Orange, N. J.)	Jun. Assoc. M.	Jan. 2, 1906 Mar. 2, 1909
Yappen, Adolph. Dist. Carpenter, C., M. & St. P. Ry., Western Ave. (Res., 843 North Francisco Ave.), Chicago, Ill.		June 1, 1909
Yates, Bruce Clinton. Asst. Chf. Engr., Homestake Min. Co., Lead, S. Dak.		June 7, 1905
Yates, Eugene Adams. 94 Lafayette Ave., Brooklyn, N. Y.	Jun. Assoc. M.	Oct. 3, 1905 Oct. 2, 1907
Yates, Joseph Johnson. Bridge Engr., C. R. R. of N. J., 143 Liberty St., New York City		May 2, 1906
Yates, William Henry. Board of Water Supply, 299 Broadway, New York City	Jun. Assoc. M.	Feb. 2, 1904 Jan. 8, 1908
Yen, Te Ching. Szechuan Ry., Ichang, China	Jun. Assoc. M.	Dec. 1, 1903 April 1, 1908
Young, Charles Newton. 780 Joost Ave., San Francisco, Cal.		Feb. 2, 1909
Young, Henry Amerman. Chf. Engr., Jobson Hooker Co., 1170 Broadway, New York City (Res., 205 Warburton Ave., Yonkers, N. Y.)	Jun. Assoc. M.	Mar. 5, 1901 Dec. 2, 1903
Young, Lewis Maxwell. Care, The Concrete Steel Co., Cor. Main and Shetucket Sts., Norwich, Conn.		April 6, 1909
Young, Samuel McCain. (Of J. F. Coleman & Co., Engrs.), 920 Hibernia Bldg., New Orleans, La.		June 7, 1905
Zabriskie, Albert Menger. 161 E. Front St., Plainfield, N. J.		Dec. 4, 1907
Zachry, John Low. Asst. City Engr., 210 Spring St., Atlanta, Ga.		Nov. 7, 1906
Zimmermann, Walter Gustaf. Contr. Mgr. for the Duluth and Northern Michigan Dist. of Am. Bridge Co. of N. Y., Columbia Bldg,, Duluth, Minn.		Oct. 7, 1908
Zorn, George Washington. Hydr. and Gen. Eng., Wiley, Wyo.		Dec. 7, 1904

Associate Members, 1845.

ASSOCIATES.

[Assoc. Am. Soc. C. E.]

		Date of Membership.
Ackerman, Ernest Robinson. 1 Broadway, New York City		May 1, 1900
Ambler, Daniel Griffith. Litchfield, Conn		Mar. 7, 1906
Anderson, Robert. Vice-Pres., The Ferro-Concrete Constr. Co., 2461 Grandin Rd., Cincinnati, Ohio		Nov. 6, 1907
Atwell, Harry Hurd. Instr. in Surv., Univ. of Michigan, 732 Packard St., Ann Arbor, Mich	Jun. Assoc.	Mar. 31, 1908 Jan. 4, 1910
Auchincloss, John Winthrop. 22 William St., New York City		April 2, 1901

Belden, Edgar Tweedy. Sales Mgr., Farnum Cheshire Lime Co., Pittsfield Lime Co., Pittsfield, Mass		Mar. 5, 1901
Bennett, Leslie J. Secy., Buffalo Cement Co., 110 Franklin St., Buffalo, N. Y		Jan. 7, 1902
Bent, Stedman. Overbrook, Pa		Dec. 2, 1902
Bernegau, Rudolf Caspar Carl Marie. 127 Fulton St., New York City		Feb. 3, 1903
Bogart, Samuel Stockton. Dumont, N. J		April 7, 1886
Bouton, Harold. Counsellor at Law and Cons. Engr., 2 Rector St., New York City	Jun. Assoc.	May 2, 1899 Mar. 7, 1906
Bradley, Charles Whiting. 1064 Ellicott Sq., Buffalo, N. Y		June 19, 1891
Braine, Lawrence Fulton. Vice-Pres., The Rail Joint Co., New York City		Sept. 6, 1898
Bromley, Albert Henry, Jr. Concrete Engr., 5113 Market St., Philadelphia, Pa		Feb. 2, 1909
Brooks, David Walker. Clinton Bldg., Columbus, Ohio		Dec. 5, 1906
Brown, John Griffiths. Specialist in Reinforced Concrete, 628 Witherspoon Bldg., Philadelphia, Pa		July 9, 1906
Brown, Thane Ross. With Wisconsin Bridge & Iron Co., North Milwaukee, Wis	Jun. Assoc.	Mar. 31, 1896 Oct. 2, 1900
Bruce, John Moffatt. Gen. Sales Mgr., United Mfrs., 76th St. and Broadway, New York City		Jan. 3, 1906
Burnham, George, Jr. Director, Baldwin Locomotive Works, 1218 Chestnut St., Philadelphia, Pa	Jun. Assoc.	Jan. 6, 1875 July 2, 1890
Burrows, George Lord. Saginaw, W. S., Mich		Feb. 3, 1886

Caird, James Morton. Chemist and Bacteriologist, 271 River St., Troy, N. Y		Oct. 5, 1904

		Date of Membership.
Chapman, Mellville Douglas. Broker, 80 Broadway, New York City		Sept. 1, 1896
Chaussé, Alcide. City Archt. and Supt. of Bldgs., P. O. Box 259, Montreal, Que., Canada		April 6, 1904
Church, Irving Porter. Prof. of Applied Mechanics and Hydraulics, Cornell Univ., Ithaca., N. Y.		Oct. 1, 1901
Clark, Ludlow Victor. 619 Harrison Bldg., Philadelphia, Pa.		Oct. 4, 1892
Codwise, Henry Rogers. Instr. in Eng., Poly. Inst. of Brooklyn, Brooklyn, N. Y., and Instr. in Eng. Field Work and Math., Cooper Union Schools of Science and Art, New York City	Jun. Assoc.	April 2, 1901 April 6, 1909
Colby, Safford Kinkead. Treas., Pierson, Roeding & Co., 409 Monadnock Bldg., San Francisco, Cal.	Jun. Assoc.	Mar. 5, 1895 Jan. 6, 1904
Cole, George Nathan. Eastern Representative, Cross Horizontal Folding & Warehouse Door Co., 1328 Broadway, New York City		Oct. 2, 1907
Colsten, Albert Lloyd. Prof., Applied Mathematics and Design, Manual Training High School, Brooklyn, N. Y.		Sept. 3, 1901
Comfort, Silas Gildersleeve. Vice-Pres. and Prof. of Eng., Pennsylvania Military Coll., Chester, Pa.		Mar. 31, 1891
Compton, Alfred G. Prof. of Physics, The Coll. of the City of New York, 17 Lexington Ave. (Res., 40 West 126th St.), New York City		Sept. 5, 1877
Conard, William Roberts. Inspections and Tests of Materials, Room 5, Savings Institution Bldg., Burlington, N. J.		Jan. 3, 1906
Constance, Edward Cartwright. Surv., U. S. Engr. Office, Custom House, St. Louis, Mo.	Jun. Assoc.	Dec. 6, 1904 Feb. 6, 1907
Copeland, William Rogers. Chf. Chemist, Board of Public Service, Water Dept., Columbus, Ohio		Feb. 4, 1902
County, Albert John. Asst. to 2d Vice-Pres., P. R. R. Co., 225 Broad St. Station, Philadelphia, Pa.		Aug. 31, 1909
Currier, Charles Gilman. 313 West 102d St., New York City.		June 21, 1894
Cushman, Allerton Seward. Office, Public Roads., U. S. Dept. of Agriculture, Washington, D. C.		Nov. 8, 1909
Dailey, John Alexander. 260 Glenwood Ave., East Orange, N. J.		Sept. 7, 1904
Denio, George La Pierre. 15 East Dayton St., Ridgewood, N. J.		July 9, 1906
Dewey, Charles Ellis. 46 Bank Bldg., Watertown, N. Y.		Nov. 5, 1901
de Wyrall, Cyril. Chf. Insp., Interborough Rap. Trans. Co., Subway Div., New York City		Feb. 6, 1907
Diven, John M. Care, Light & Water Co., George St., Charleston, S. C.		Sept. 10, 1891
Douglass, Anthony Chileon. Mayor, Niagara Falls, N. Y.		April 30, 1895
Drummond, Thomas Joseph. Pres., Lake Superior Corporation, Montreal, Que., Canada		Mar. 6, 1894

		Date of Membership.
Eckel, Edwin Clarence. Cons. Engr. and Geologist, 208 Munsey Bldg., Washington, D. C.		Mar. 5, 1901
Eglee, Charles Henry. Gen. Mgr., Ambursen Hydr. Constr. Co., 176 Federal St., Boston, Mass.		July 10, 1907
Elliott, Howard. Pres., N. P. Ry., St. Paul, Minn.		June 5, 1900
Farrell, Edward James. 159 West 125th St., New York City.		June 6, 1899
Ferris, James Joseph. Supt., F. M. Stillman Co., Gen. Contrs., 26 Exchange Pl., Jersey City, N. J.		July 10, 1907
Fishburne, Edward Bell, Jr. Pres., Hoge Memorial Military Academy, Blackstone, Va.		Dec. 5, 1899
Fisk, Wilbur Chapman. 30 Church St., New York City.		Oct. 4, 1892
Foster, Clarence Marvin. Secy., Meacham & Wright Co., 805 Corn Exchange Bank Bldg., Chicago, Ill.		Jan. 31, 1899
Frost, George Henry. Pres. and Treas., The Eng. News Pub. Co., 220 Broadway, New York City.		Jan. 4, 1882
Fuller, Almon Homer. Prof. of Civ. Eng. and Dean, Coll. of Eng., Univ. of Washington, University Station, Seattle, Wash.	Jun. Assoc.	April 4, 1899 Feb. 4, 1902
Futami, Kyosaburo. Prof. of Civ. Eng., Kyoto Imperial Univ., Kyoto, Japan.		June 5, 1899
Gaines, Franklin Lincoln. 236 So. Fuller St., Grand Rapids, Mich.		April 1, 1902
Gildersleeve, Alger Crocheron. 215 West 125th St., New York City.	Jun. Assoc.	Feb. 6, 1894 April 4, 1899
Goldsborough, John Byron. Gen. Mgr., Jules Breuchaud Constr. Co., 290 Broadway, New York City.		April 4, 1899
Goodell, John Milton. Editor *The Engineering Record*, 239 West 39th St., New York City.		July 29, 1891
Graham, William Woodman. Care, E. Stahlknecht & Co., Durango, Mexico.		Dec. 6, 1898
Graves, Edward Michael. 17 Commercial Bank Bldg., Cleveland, Ohio.		Mar. 2, 1909
Green, Frederick William. Gen. Supt., L. & A. Ry., Stamps Ark.		May 1, 1907
Green, Howard Burkhardt. 1718 Land Title Bldg., Philadelphia, Pa.		Mar. 4, 1908
Hardwicke, Alan Hyde Gardner. Gluck Bldg., Niagara Falls, N. Y.		June 4, 1884
Harrison, Louis Baldwin. Cons. and Contr. Engr., 21 Park Row, New York City.		May 5, 1896
Hartmann, Ernest Frederick. Pres., Carbolineum Wood Preserving Co., 182 Franklin St., New York City.		Jan. 4, 1910

	Date of Membership.
Hartranft, William Garrigues. Pres., Wm. G. Hartranft Cement Co., Real Estate Trust Bldg., Broad and Chestnut Sts., Philadelphia, Pa	May 3, 1898
Hays, John Coffee. Visalia, Cal	May 4, 1909
Hayward, Harrison Washburn. Asst. Prof., Applied Mechanics, Mass. Inst. Tech., Boston, Mass	June 6, 1906
Hazen, John Vose. Prof. of Civ. Eng., Dartmouth Coll., Hanover, N. H	June 5, 1889
Healy, John Robert. 430 West 118th St., New York City	Jan. 8, 1908
Herron, George Merrick. P. O. Box 353, Palo Alto, Cal	Jun. April 2, 1907 Assoc. Feb. 2, 1909
Holden, Charles Arthur. Prof. of Civ. Eng., Thayer School of Civ. Eng., Dartmouth Coll., Hanover, N. H	Nov. 1, 1905
Howe, James Vance. Instr. in Civ. Eng., Missouri School of Mines, Rolla, Mo.; Address, 205 Willey St., Morgantown, W. Va	Nov. 30, 1909
Hughes, Harold Lincoln. Sales Mgr. and Res. Engr., United States Steel Products Export Co., G. P. O. Box 384, Sydney, New South Wales, Australia	April 1, 1908
Hunt, Carlton Eugene. With Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	Oct. 3, 1906
Hurst, George Joseph. 558 West 184th St., New York City	Nov. 7, 1906
Huston, James Archibald. Gen. Mgr., Am. Bridge Co., 826 Frick Bldg., Pittsburg, Pa	Aug. 31, 1897
Jacoby, Henry Sylvester. Prof. of Bridge Eng., Cornell Univ., 7 Reservoir Ave., Ithaca, N. Y	Nov. 5, 1890
Johnson, Arthur Augustine. Sanford Ave. and 21st St., Flushing, N. Y	Sept. 2, 1908
Jordan, Harry Edward. San. Engr., Indianapolis Water Co., 113 Monument Pl., Indianapolis, Ind	Aug. 31, 1909
Kaltenbach, Henry Julius. Park Hill, Yonkers, N. Y	June 3, 1902
Karner, William Josiah. Secy. and Treas., Bowne & Co., Inc., 81 Beaver St., New York City	July 2, 1890
Keller, Otto Balthazar. Eng. and Govt. Representative of Keuffel & Esser Co., 127 Fulton St., New York City	Feb. 3, 1903
King, Harry Wheelock. Vice-Pres., The King Bridge Co., Cleveland, Ohio	June 19, 1891
King, Wallace, Jr. Vice-Pres., United Bldg. Material Co., 320 Broadway, New York City	Dec. 4, 1900
Kornfeld, Alfred Ephraim. Mgr., *Engineering News*, 220 Broadway, New York City	Oct. 7, 1908
Lally, John Michael. Mgr., The Brookfield Glass Co., Old Bridge, N. J	Sept. 2, 1908

		Date of Membership.
Leather, Basil Henry. 1133 Broadway, New York City		June 1, 1904
Lee, Robert Hileman. Bridge Dept., L. S. & M. S. Ry., Cleveland, Ohio		May 2, 1906
Lesley, Robert Whitman. Pres., Am. Cement Co., 604 Pennsylvania Bldg., Philadelphia, Pa		Jan. 31, 1893
Liebmann, Alfred. 57 West 58th St., New York City		June 3, 1902
Livingston, Julius I. Bound Brook, N. J		July 3, 1889
Lober, John Baptiste. 1230 Land Title Bldg., Philadelphia, Pa.		July 9, 1906
Lundberg, John Hervid. 1188 Sterling Pl., Brooklyn, N. Y.		April 3, 1907
MacGregor, John. Engr., The United States Fidelity & Guaranty Co. of Baltimore, 126 No. Ashland St., Buffalo, N. Y		June 2, 1903
McBurney, Henry. Asst. Engr., Office of Engr. of Bridges, N. Y., N. H. & H. R. R. Co., New Haven, Conn	Jun. Assoc.	Jan. 5, 1904 Nov. 6, 1907
McIntire, Thomas Burton. 52 Vernon Pl., Sherwood Park, Yonkers, N. Y	Jun. Assoc.	Mar. 1, 1904 Oct. 3, 1906
Maignen, Jean Prosper Auguste. Filtration Engr., 52 North 13th St., Philadelphia, Pa		Oct. 3, 1899
May, Theodore Martin. 95 Liberty St., New York City		Dec. 7, 1904
Meriwether, Coleman. Pres. and Chf. Engr., Lock Joint Pipe Co., 165 Broadway, New York City		Feb. 7, 1906
Meyer, Henry Coddington, Jr. Cons. Mech. Engr., 1 Madison Ave., New York City (Res., Montclair, N. J.)	Jun. Assoc.	Jan. 3, 1893 Dec. 28, 1900
Monahan, John Joseph. Builder, West Chelmsford, Mass.		June 1, 1904
Monks, John, Jr. 82 Beaver St., New York City		May 31, 1898
Moore, Lewis Eugene. Asst. Prof. of Civ. Eng., Mass. Inst. Tech., 85 Washington Park, Newtonville, Mass		April 1, 1908
Morris, Davis Harrington. Special Agt., Central Union Telephone Co., Dayton, Ohio		Nov. 6, 1907
Moxham, Arthur James. Room 926, du Pont Bldg., Wilmington, Del		Nov. 2, 1887
Moyer, Albert. 200 Fifth Ave., New York City		Feb. 7, 1906
Oastler, William Churchill. 200 West 56th St., New York City		Mar. 31, 1891
Odell, Rutledge Irving. Vice-Pres., The Tomkins Cove Stone Co., Tomkins Cove, N. Y		Oct. 1, 1895
Olds, William Clarence. Erie, Pa		Nov. 3, 1903
Packard, Ralph Gooding, Jr. Vice-Pres., R. G. Packard Co., 130 Pearl St., New York City		Sept. 3, 1901
Palmer, William Pendleton. Pres., Am. Steel & Wire Co., Western Reserve Bldg., Cleveland, Ohio		Mar. 3, 1896

		Date of Membership.
Parsons, George Wellman. Cons. Engr., Pennsylvania Steel Co., Steelton, Pa.		Sept. 3, 1884
Patton, Alfred Gaunt. Engr. and Chf. of the Special Hazard Dept. of the New York Fire Insurance Exchange, The Oaks, Fisher's Lane, Germantown, Philadelphia, Pa.		Dec. 6, 1905
Phelps, Earle Bernard. Cons. San. Engr., 30 Church St., New York City		Mar. 4, 1908
Phillips, Henry Ayling. Archt., 120 Tremont St., Boston, Mass.		April 7, 1886
Phipps, Lawrence Cowle. 1154 East Colfax Ave., Denver, Colo.		Jan. 31, 1899
Pinchot, Gifford. Forester, U. S. Dept. of Agriculture, 1615 Rhode Island Ave., N. W., Washington, D. C.		Mar. 4, 1902
Piper, Alexander Ross. Capt., U. S. A. (*Retired*); Gen. Freight Agt., South Brooklyn R. R. and Gen. Supt., Am. Ry. Traffic Co., 85 Clinton St. (Res. 7522 Second Ave.), Brooklyn, N. Y.		June 5, 1900
Polk, William Anderson. Associated with The Lowe Bros. Co., Dayton, Ohio; Address, The Engineers' Club, New York City		May 4, 1897
Pomeroy, Lewis Roberts. Asst. to the Pres. of the Safety Car Heating & Lighting Co., 2 Rector St., New York City		April 2, 1890
Poorman, Alfred Peter. Asst. Prof. of Mechanics, Purdue Univ., 306 Salisbury St., West Lafayette, Ind.		Oct. 7, 1908
Quilty, Thomas Frank. Gen. Eng. Contr. (John J. O'Heron & Co.), 6 Wabash Ave., Chicago, Ill.		April 5, 1905
Quincy, Charles Frederick. 90 West St., New York City		Feb. 4. 1896
Ransome, Ernest Leslie. 910 Madison Ave., Plainfield, N. J.		June 5. 1894
Saeger, Charles Marshall. Gen. Mgr., Coplay Cement Mfg. Co., 1320 Hamilton St., Allentown, Pa.		May 2, 1893
Sass, Charles William. Supt. of Constr., S. Pearson & Son, Inc., Penn., N. Y. & L. I. R. R. Co., East River Tunnels Contract (Res., 465 East 140th St.), New York City.		Nov. 4, 1908
Scribner, Gilbert Hilton, Jr. Engr. and Contr., 184 La Salle St., Chicago, Ill.		April 5, 1905
Sell, William Drumm. Chf. Engr. and Asst. Gen. Mgr., Gallego Coal & Land Co. and The Ohio Timber Co., Kanawha Valley Bank Bldg., Charleston, Kanawha Co., W. Va.	Jun. Assoc.	Dec. 3, 1891 May 2, 1899
Shanley, James Roosevelt. 527 Fifth Ave., New York City		Mar. 6, 1907
Smith, Albert. 1022 Seventh St., West Lafayette, Ind.		April 3, 1907

		Date of Membership.
Smith, Cameron C. Pres. and Gen. Mgr., Union Steel Casting Co., Pittsburg, Pa		June 5, 1907
Smith, Francis Hopkinson. 16 Exchange Pl., New York City.		April 5, 1892
Smith, Francis Vinton. Hotel Belnord, 86th St. and Broadway, New York City		Oct. 7, 1908
Smith, Herbert Stearns Squier. Prof. of Civ. Eng., Princeton Univ., 58 University Pl., Princeton, N. J		Sept. 10, 1891
Smith, Walter Townsend. 215 West 23d St., Box 706, New York City		Oct. 7, 1908
Snare, Frederick. Pres., The Snare & Triest Co., Contr. Engrs., 143 Liberty St., New York City		Oct. 6, 1903
Sommer, Albert. Cons. Chemist of The Texas Co., 17 Battery Pl., New York City		Feb. 1, 1910
Speed, James Breckinridge. 325 West Main St., Louisville, Ky		May 2, 1888
Stilson, Minott Augur Osborn. 172 Chestnut Ave., Waterbury, Conn		Feb. 5, 1908
Stowe, Charles Brown. The Stowe Fuller Co., Cleveland, Ohio.		Oct. 4, 1898
Stroebe, George Gottlieb. Walkerville, Ont., Canada		Nov. 4, 1908
Struckmann, Holger. Third Vice-Pres. and Chf. Engr., Union Sand & Material Co., 6330 Washington Bldg., St. Louis, Mo		Nov. 30, 1909

Talbot, Frank Mayhew. Glen Ridge, N. J		May 4, 1909
Tenney, George Oliver. Pres., Atlantic Bitulithic Co., Richmond, Va	Jun. Assoc.	Sept. 7, 1887 Feb. 5, 1901
Thompson, Edward Percival. Engr., Const., and Supt. of Refineries, Philippine Products, Manila, Philippine Islands.		June 5, 1907
Thorn, Alfred William. Gen. Mgr., Thorn Cement Co., 445 Delaware Ave., Buffalo, N. Y		Oct. 2, 1900
Toch, Maximilian. Chemist for Toch Bros., 320 Fifth Ave., Room 709, New York City		Sept. 1, 1903
Tomkins, Calvin. 17 Battery Pl., New York City		Jan. 6, 1886
Townsend, Frederick Eugene. 311 West 95th St., New York City		April 6, 1909
Trautwine, John Cresson, Jr. 257 South 4th St., Philadelphia, Pa		Dec. 5, 1888
Turrill, Sherman Marsh. Engr. with Ralph Modjeski, 1750 Monadnock Blk., Chicago, Ill		Oct. 1, 1901

Usina, Domingo Anthony. Civ. Engr. and Counselor in Patent Law, 170 Broadway, New York City		Mar. 1, 1905

Van Name, Joseph Mason. 1258 Bergen St., Brooklyn, N. Y.		April 3, 1907
von Schrenk, Hermann. Supervisor, Timber Preservation, Frisco-Rock Island System, Tower Grove and Flad Aves., St. Louis, Mo		July 10, 1907

		Date of Membership.
Warder, John Haines. Secy., Western Society of Engrs., 1735 Monadnock Blk., Chicago, Ill		Mar. 7, 1888
Waterbury, Leslie Abram. Prof. of Civ. Eng., Univ. of Arizona, Tucson, Ariz		Nov. 7, 1906
Watson, Merrill. 42 Spring St., Newark, N. J		Oct. 7, 1902
Watt, James Robert. Pres., United Constr. Co., 467 Broadway, Albany, N. Y		June 3, 1908
Weber, George Adam. 71 Courtland Ave., Stamford, Conn		Feb. 6, 1900
Wells, Joseph Agur. The Fairbanks Co., Broome and Elm Sts., New York City		Jan. 7, 1896
Willson, Frederick Newton. Prof. of Descriptive Geometry and Technical Drawing, Princeton Univ., Box 63, Princeton, N. J	Jun. Assoc.	Sept. 5, 1883 Oct. 4, 1892
Woodbury, John McGaw. Care, Gen. Elec. Co., 30 Church St., New York City		Feb. 7, 1906
Wrenn, James Francis. Franklin Furnace, N. J		Sept. 6, 1905
Young, Charles Griffith. Engr. and Contr., 60 Wall St., New York City		Mar. 6, 1894

Associates, 166.

JUNIORS.

[Jun. Am. Soc. C. E.]

	Date of Membership.
Abbott, Hunley. Care, MacArthur Bros. Co., 11 Pine St., New York City	Sept. 5, 1905
Abrams, Duff Andrew. Associate, Eng. Experiment Station, Univ. of Illinois, Urbana, Ill	Jan. 2, 1906
Adey, John Seager. Care, Bliss & Griffiths, 225 Fifth Ave., New York City	Feb. 3, 1903
Affleck, Myron Hopkins Strong. Asst. Engr., American Extractor Corporation, 10 Weybosset St., Providence, R. I.	Feb. 4, 1908
Alderson, William Howard. Cons. Engr.'s Office, S. P. Co., Union Pacific System, 135 Adams St., Chicago, Ill	Dec. 5, 1905
Allen, Chester Salisbury. Concrete Engr., Lockwood, Greene & Co., Boston, Mass	Dec. 4, 1906
Allen, Harold Dayton. Transitman, C. R. R. Co. of N. J., Jersey City, N. J	April 30, 1907
Anderberg, Edward. Asst. Engr., Barge Canal Office, Lockport, N. Y	Mar. 5, 1907
Anderson, Lowrey Wallace. Asst. Engr., Tex. & Pac. Ry. Co., Dallas, Tex	April 6, 1909
Andrews, George Crowell. Asst. Engr. in Chg., Contract 10, New York State Barge Canal, Fulton, N. Y	Aug. 31, 1909
Andrus, Leonard Alexander. Care, W. C. Andrus, Grand Detour, R. F. D., Dixon, Ill	Jan. 7, 1908
Appel, Harris Arkush. P. O. Box 504, Colorado Springs, Colo.	Mar. 2, 1909
Apple, Charles E. Columbus, Miss	Mar. 5, 1907
Armstrong, George Simpson, Jr. 1058 East 19th St., Brooklyn, N. Y	Jan. 5, 1909
Ashbrook, Chester Daniel. Care, King County Engr.'s Office, Seattle, Wash	May 4, 1909
Atwood, William Bartlett. Supt., Ashtabula Rapid Transit Co.; Asst. Supt., Penn. & Ohio Ry., 350 Main St., Ashtabula, Ohio	April 30, 1907
Auten, Claude Isaac. City Engr., Flint, Mich	Sept. 1, 1908
Ayres, Louis Evans. With Gardner S. Williams, Cons. Engr., Ann Arbor, Mich	Dec. 1, 1908
Babcock, Franklin. 1720 Broadway, San Francisco, Cal	Mar. 2, 1909
Bacon, Arthur Whittemore. Care, Hall & Bacon, Civ. and Cons. Engrs., National Bank Bldg., New Britain, Conn.	Dec. 5, 1905

	Date of Membership.
Baldridge, James Ramsey. 203 Washington Park, Brooklyn, N. Y.	Dec. 4, 1906
Banker, Edward Warren. Capt., U. S. Marines; Asst. Quartermaster, Navy Yard, Philadelphia, Pa.	Mar. 1, 1904
Banks, Charles Wilbur. P. O. Box 754, Mt. Kisco, N. Y.	Feb. 5, 1907
Barker, James Madison. With Am. Bridge Co., 117 College Ave., Elmira, N. Y.	Oct. 1, 1907
Barker, Ludlow Osmond, Jr. U. S. Engr. Office, Wheeling, W. Va.	Jan. 3, 1907
Barlow, Alfred Eugene, Jr. 854 Lafayette Ave., Brooklyn, N. Y.	April 2, 1907
Barlow, James Evans. Engr. with Bureau of Municipal Research, 911 Neave Bldg., Cincinnati, Ohio	Sept. 4, 1906
Barnard, Elmer Ellsworth. Asst. City Engr., Krise Bldg., Lynchburg, Va.	Jan. 31, 1905
Barnes, Harry Everett. Asst. Engr., Board of Water Supply, Box 113, Stone Ridge, Ulster Co., N. Y.	Mar. 2, 1909
Barrett, Robert Edward. Asst. Engr. Designer, N. Y. Board of Water Supply, 299 Broadway, New York City	Jan. 31, 1905
Barshell, Frederick Bayard. Asst. Civ. Engr., Public Service Comm., 1st Dist., State of New York, 154 Nassau St., New York City	May 1, 1906
Bates, Lindon, Jr. Cons. Engr., Western Eng. Corporation, 115 Broadway, New York City	Jan. 3, 1907
Battie, Herbert Scandlin. Box 265, Greensboro, N. C.	Dec. 1, 1908
Becker, Elvin Jay. Asst. Engr. in Chg. of Constr., Contract No. 11, Barge Canal, Waterford, N. Y.	April 3, 1906
Becker, Rudolph Conrad. 339 East 68th St., New York City	April 30, 1907
Beebee, Ralph Agustus. 551 University Ave., Palo Alto, Cal.	Sept. 1, 1908
Bellows, Sidney Raymond. 174 McClellan St., Schenectady, N. Y.	Oct. 1, 1907
Belzner, Theodore. Bridge Insp. (Maintenance); Insp., Steel Constr., Williamsburgh Bridge, Dept. of Bridges, City of New York, 84 Broadway, Brooklyn, N. Y. (Res., 614 West 135th St., New York City)	Oct. 5, 1897
Benedict, Farrand Northrop. Engr., Thomas Crimmins Contr. Co., 444 East 69th St., New York City	June 4, 1907
Benedict, Nathan. Asst. Engr., United Fruit Co., Limon, Costa Rica	Oct. 1, 1907
Bennet, Orville Green, Jr. Care, W. M. Bennet, Bank of America, 46 Wall St., New York City	June 5, 1906
Benton, Lewis Steuerwald. 540 West 159th St., New York City	Nov. 5, 1901
Bergman, Harry Montifiore. Asst. Engr., Godwin Constr. Co., 30 Church St., New York City	May 4, 1909

	Date of Membership.
Bernstein, Lester. Field Engr., Dept. of Surveys, B. & O. R. R. Co., Mt. Royal Station, Baltimore, Md	Feb. 28, 1905
Beswick, James Everett. Asst. Engr., Board of Water Supply; Res., 332 West 58th St., New York City	July 1, 1909
Biggs, Carroll Addison. Office of Engr. of Structures, N. Y. C. & H. R. R. R., 11 West 129th St., New York City	Sept. 1, 1908
Billwiller, Ernest Oswald. 167 Washington Ave., San José, Cal	Nov. 8, 1909
Bilyeu, Charles Smith. Draftsman, Office of Chf. Engr. of Elec. Traction, P. T. and T. R. R. Co., 10 Bridge St. (Res., 401 West 117th St.), New York City	Dec. 1, 1908
Bingham, Clarence Arminger. Engr. and Commr. of Streets, Carlisle, Pa	June 5, 1906
Bishop, Hiram Nelson. Care, Ransome Concrete Co., Crocker Bldg., San Francisco, Cal	Oct. 1, 1907
Bishop, Lyman Edgar. 3787 Franklin, Denver, Colo	May 4, 1909
Bixby, William Flint. (Bixby & White, Civ. and Hydr. Engrs.), 502 Mason Bldg., Los Angeles, Cal	Feb. 5, 1907
Black, Roger Derby. 1st Lieut., Corps of Engrs., U. S. A., Fort Leavenworth, Kans	Jan. 3, 1905
Blackburn, Nathaniel Townsend. U. S. Junior Engr., U. S. Engr. Office, Galveston, Tex	Sept. 6, 1904
Bluhm, Herman William. Draftsman, Isthmian Canal Comm., Corozal, Canal Zone, Panama	Nov. 8, 1909
Bock, Carl August. Locating Engr., Antofagasta & Bolivia Ry., Casilla 43, Oruro, Bolivia	Aug. 31, 1909
Bogert, Clinton Lathrop. Asst. Engr., Headquarters Dept., Board of Water Supply, 299 Broadway, New York City	Sept. 1, 1908
Boniface, Arthur. Asst. Engr., Rapid Transit Subway Constr. Co., 165 Broadway, New York City	Jan. 2, 1906
Borland, Bruce. 2922 Prairie Ave., Chicago, Ill	Mar. 3, 1903
Bowditch, Ernest W. Landscape Gardener and Civ. Engr., 68 Devonshire St., Boston, Mass	Feb. 3, 1875
Brainard, Albert Sereno. 9 Burnside Ave., East Hartford, Conn	Oct. 6, 1908
Brainerd, Harold Affleck. With Am. Bridge Co., Elmira, N. Y	Nov. 30, 1909
Breitzke, Charles Frederick. Asst. Engr., N. Y. State Dept. of Health, Albany, N. Y	Dec. 3, 1907
Bremer, Lewis Paul. 177 Winyah Ave., New Rochelle, N. Y	Feb. 6, 1906
Brennan, Joseph Lawrence. 223 West 167th St., New York City	Jan. 5, 1909
Breuchaud, Jules Rowley. 290 Broadway, New York City	Nov. 1, 1904
Brewer, Willard Seymour. City Engr.'s Office, Hartford, Conn.	Sept. 3, 1907
Broadhurst, William George. Contr., Passaic St., Hackensack, N. J	Sept. 3, 1907

	Date of Membership.
BROOKS, JOHN NIXON. 240 W. State St., Trenton, N. J.	Nov. 8, 1909
BROOKS, JOSIAH RICHARDSON. 703 E. High St., Mt. Vernon, Ohio	Feb. 2, 1909
BROWN, ARTHUR ROBERT. Care, Col. W. L. Sibert, Div. Engr., Gatun, Canal Zone, Panama	Jan. 2, 1906
BROWN, DAVID HARELL. Constr. Engr., Diamond Water Co., Bachman House, Hazleton, Pa.	Feb. 4, 1908
BROWN, GROVER CHARLES. Junior Engr., Am. Section, International Waterways Comm., 727 Elmwood Ave., Buffalo, N. Y.	June 2, 1908
BROWN, ROBERT HUSE. Asst. Engr. with Nicholas S. Hill, Jr., 100 William St. (Res., 21 West 127th St.), New York City	June 6, 1905
BROWN, WILLIAM CLINTON. Mech. Engr., 512 William St., Montreal, Que., Canada	Sept. 1, 1886
BRUA, ELMER GEORGE. Asst. Engr., Monterey County Water-Works, Monterey, Cal.	Feb. 6, 1906
BRUNTLETT, EUGENE HARRY. Engr. with the Security Bridge Co., 2401 Harriet Ave., Minneapolis, Minn.	June 6, 1905
BUDELL, ALFRED EDWARD. 95 Liberty St., New York City	Oct. 1, 1907
BURKE, RALPH HANEY. Computer, Sanitary Dist. of Chicago, 1546 South Kedzie Ave., Chicago, Ill.	Dec. 4, 1906
BURNHAM, GEORGE EARLE. Care, Bureau of Lands, Manila, Philippine Islands	Oct. 1, 1907
BURNS, WALTER ELLIOTT. 1811 Milvia St., Berkeley, Cal.	Mar. 5, 1907
BURPEE, GEORGE WILLIAM. Care, Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	Sept. 3, 1907
BURR, MYRON CARLOS. Civ., Hydr. and Min. Engr. (Burr & Fergusson), Loo Bldg., Vancouver, B. C., Canada	May 4, 1909
BURROUGHS, FREDERIC. Asst. Supt., Filtration Div., Bureau of Water, 621 North St. Clair St., Pittsburg, Pa.	June 4, 1907
BURROUGHS, HECTOR ROBINS. Asst. Engr., Sanderson & Porter, Hotel Robins, San Francisco, Cal.	Mar. 3, 1908
BURTON, WAYNE JOSEPH. Div. Engr., Mo. Pac. Ry., St. Louis, Mo.	Sept. 4, 1906
BUSHELL, ARTHUR WILLIAM. Bureau of Lands, Manila, Philippine Islands	Oct. 1, 1907
BUSHNELL, HOWARD EMORY. Care, H. K. Curtin & Co., 836 Real Estate Trust Bldg., Philadelphia, Pa.	Mar. 6, 1906
CAHILL, JAMES EDWARD. 1316 Chamber of Commerce, Chicago, Ill.	Mar. 31, 1908
CAHILL, JOHN RICHARD. 136 Belvedere St., San Francisco, Cal.	April 30, 1907
CALDER, JOHN WEBSTER. Asst. in Math. and Surveying, Rens. Poly. Inst., Troy, N. Y.	Sept. 1, 1908

	Date of Membership.
CALDWELL, FRED EDWARD. Newton, N. J.	April 3, 1906
CALDWELL, JOHN WORDE. Care, U. S. Engr. Office, McCandless Bldg., Honolulu, Hawaii	Aug. 31, 1909
CALHOUN, DAVID ADAMS. Cons. Engr., 35 Nassau St., New York City	Oct. 6, 1908
CAMERON, KENNETH MACKENZIE. Prin. Asst. Engr., Public Works Dept. (Res., 793 Hellmuth Ave.), London, Ont., Canada	Oct. 6, 1903
CANTWELL, HERBERT HERLUIN. Asst. Supervisor of Track, N. Y. C. & H. R. R. R., 138th St. Station, New York City	Dec. 3, 1907
CARBAJAL, FERNANDO. Care, Engineering Society, Lima, Peru	Jan. 7, 1908
CARLISLE, ORVILLE BERTON. 235 Fourteenth St., Milwaukee, Wis	Sept. 4, 1906
CARPENTER, J. C. City Engr. and Surv., Watertown, S. Dak	Nov. 8, 1909
CARTER, LESTER LEVI. Box 665, Fresno, Cal	Sept. 3, 1907
CATER, WALTER DAY. Civ. Engr. for the Am. Cement Eng. Co., Yorktown, Va	Nov. 30, 1909
CHACE, AMASA MANTON. 10 Bay View Ave., Newport, R. I.	Oct. 5, 1909
CHADWICK, CHESTER ROBERT. Bridge Dept., E. Z. Impvt., N. Y. C. & H. R. R. R., 335 Madison Ave., New York City	Feb. 5, 1907
CHAFETZ, HERMAN. 80 Pratt St., Buffalo, N. Y	June 1, 1909
CHANDLER, EMERSON LAWRENCE. 16 Squire St., New London, Conn	Nov. 8, 1909
CHANDLER, HORACE EDWARD. In Chg. of Dept. of Physics, Coll. of Arts and Sciences, Shantung Christian Univ., Weihsien, Shantung Province, China	Sept. 4, 1906
CHAPMAN, ARNOLD GOODWIN. Chf. Clerk, Dept. of State Engr. and Surv., State of New York, Albany, N. Y	July 1, 1909
CHAPPELL, CLAUDE EDWARD. City Engr., 247 Britain Ave., Benton Harbor, Mich	Sept. 1, 1908
CHESTER, CHARLES PORTER. Cons. Engr., 512 Caples Bldg., El Paso, Tex	Feb. 4, 1908
CHEVALIER, LOUIS. Asst. Bridge Engr., Seaboard Air Line Ry. (Res., Virginia Apartments), Portsmouth, Va	May 1, 1906
CHEVALIER, WILLARD TOWNSHEND. Asst. Engr., Public Service Comm. for the 1st Dist., Tribune Bldg., New York City	April 6, 1909
CHIBA, TOSHITOMO. Care, Mr. Narisawa, 5, Kitajimacho 2 Chome, Nihonbashiku, Tokyo, Japan	Mar. 31, 1908
CHURCH, ELIHU CUNYNGHAM. Lecturer in Civ. Eng., Columbia Univ.; Cons. Engr., 4 East 130th St., New York City	May 1, 1906
CLARK, LE ROY WALTER. Asst. in Rational and Technical Mechanics, Rens. Poly. Inst., 101 Hoosick St., Troy, N. Y.	Sept. 4, 1906
CLARK, WILLIAM GEORGE. Civ. and Cons. Engr., 1050 Spitzer Bldg., Toledo, Ohio	April 4, 1888
CLAUSNITZER, JOHN. 157 East 21st St., New York City	Mar. 3, 1903

	Date of Membership.
Clayton, Henry Helm. Asst. Engr., Mo. Pac. Ry., Kirkwood, Mo.	Dec. 3, 1907
Cleveland, Lou Baker. Cleveland Bldg., Watertown, N. Y.	Sept. 1, 1908
Clifford, Walter Woodbridge. Asst. in Civ. Eng., Mass. Inst. of Tech., 60 Oak St., Hyde Park, Mass.	Nov. 8, 1909
Closson, Edgar Stone. Asst. Engr., Public Service Comm., First Dist., 1047 East Tenth St., Brooklyn, N. Y.	Sept. 4, 1906
Cobb, Samuel Allen. Civ. Engr., Eng. Dept., Portland, Ore.	June 3, 1902
Coburn, Horace Butterfield, Jr. 275 Andover St., Lowell, Mass.	Oct. 30, 1906
Cochran, Jerome. Pres. and Chf. Engr., Jerome Cochrane Co., First National Bank Bldg., Houston, Tex.	Sept. 1, 1908
Coffin, Theodore DeLong. Katonah, N. Y.	Nov. 1, 1904
Cole, Alden Brigham. Asst. Engr., N. Y., O. & W. Ry., Carbondale, Pa.	Sept. 3, 1907
Colgan, Robert Joseph. 226 N. 2d St., Harrisburg, Pa.	Sept. 1, 1908
Collar, William Franklin. Supt., The Foundation Co., P. O. Box 558, Hibbing, Minn.	April 6, 1909
Collins, Francis Winfield. Care, Constr. Service Co., 15 William St., New York City	Jan. 2, 1906
Cook, Henry Aten. 160 Fifth Ave., Room 714, New York City.	Oct. 30, 1906
Cook, John Wheeler. Asst. Engr., O'Rourke Eng. Constr. Co., 345 Fifth Ave., New York City	Oct. 30, 1906
Coombs, Arthur Wellesley. Asst. Engr., B. R. T. Co., 135 Remsen St., Brooklyn, N. Y.	Oct. 1, 1907
Cope, Erle Long. Engr. in Chg. of Constr., Boalt Hall, Univ. of California, Berkeley, Cal.	Jan. 7, 1908
Copeland, Frederick Lucius. Asst. Supt., Bates & Rogers Cons. Co., 355 Dearborn St., Chicago, Ill.	Nov. 5, 1907
Corp, Henry William. Surv., Bureau of Public Lands, Manila, Philippine Islands	Oct. 1, 1907
Cortright, Edwin Keen. Beverly, N. J.	Feb. 4, 1908
Cotton, Miles Penner. Engr. and Gen. Contr., 27 Davis Chambers, Vancouver, B. C., Canada	Oct. 6, 1903
Coyne, Harry Lewis. Asst. Engr., Public Service Comm. for First Dist., 509 West 146th St., New York City	Feb. 5, 1907
Crane, Will Edwin. 77 Van Siclen Ave., Brooklyn, N. Y.	May 1, 1889
Crawley, Ernest Willard. U. S. Junior Engr., 407 First National Bank Bldg. (Res., 299 Norton St.), New Haven, Conn.	May 31, 1904
Crooks, Clinton Hervey. Asst. Engr., Rapid Transit Subway Constr. Co. (Res., 204 West 94th St.), New York City	Oct. 3, 1905
Crow, Edward. Engineering School, Wanganui, New Zealand.	Oct. 3, 1905
Crowell, Francis Stirling. Asst. Engr., Dept. of State Engr. and Surv., Barge Canal Office, Albany, N. Y.	Feb. 6, 1906
Cunningham, John Earl. 9 Willow St., Boston, Mass.	Sept. 5, 1905

	Date of Membership.
Cunningham, John Wilbur. Draftsman, Bridge Dept., North Coast R. R. Co., 621 E. Indiana Ave., Spokane, Wash.	Aug. 31, 1909
Cunningham, Pinkney Edward. U. S. Junior Engr., P. O. Box 404, Vicksburg, Miss.	July 1, 1909
Cutler, Stanley Gardner. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands	May 4, 1909
Dann, Alexander William. Box 404, Vicksburg, Miss.	Feb. 4, 1908
Davis, Charles Moss. U. S. Engr. Office, Galveston, Tex.	Jan. 3, 1907
Davis, George Walker. Surv., Bureau of Lands, Manila, Philippine Islands	Feb. 4, 1908
Day, William Peyton. Asst. Engr., John B. Leonard, 344 North Willard St., San Francisco, Cal.	Mar. 6, 1906
Decker, Arthur James. Instr. in Civ. Eng., Univ. of Michigan; Asst. Engr., Gardner S. Williams, Room 207, New Eng. Bldg., Ann Arbor, Mich.	Sept. 5, 1905
de Forest, Nora Blatch. Engr., Rido Telephone Co., 103 Park Ave., New York City	Mar. 6, 1906
Dennie, Frank Edward. Univ. of Missouri, School of Mines and Metallurgy, Rolla, Mo.	Oct. 5, 1909
Densler, Frank Haskell. Transitman and Computer, Board of Water Supply, New York City; Address, 150 Pulaski St., Brooklyn, N. Y.	July 1. 1909
Derleth, Walter Taubert. Engr. with D. J. Ryan, Contr., 723 Third Ave., Brooklyn, N. Y. (Res., 224 West 139th St., New York City)	Oct. 31, 1905
Deutschbein, Harry Johnson. Supt., Bureau of Water, 25 Quackenbush St., Albany, N. Y.	Dec. 6. 1904
Dibert, Herbert McMillen. Instr. in Dept. of Civ. Eng., Univ. of Pennsylvania, Philadelphia, Pa.	April 6. 1909
Dimmler, Charles Louis. 2222 Bancroft Way, Berkeley, Cal.	Oct. 1. 1907
Doe, Charles Lee. Engr. and Contr. (Doe & Whittier), 95 Liberty St., New York City	April 3, 1906
Dorrance, Frank Young. With Bureau of Filtration, 1130 Sherwood Pl., Pittsburg, Pa.	Feb. 5, 1907
Dougherty, Richard Erwin. Dist. Engr., N. Y. C. & H. R. R. R., Grand Central Palace, New York City	Jan. 6. 1903
Driggs, Edwin Leroy. Bureau of Lands, 722 Calle Iris, Manila, Philippine Islands	Nov. 5. 1907
Dubois, Gustavo Adolfo. Constitucion 22, Matanzas, Cuba.	Sept. 1. 1908
Dunan, George Edmund. Asst. Engr., Morey-Faulhaber Constr. Co., Apalachicola, Fla.	Nov. 8. 1909
Dunmire, Elijah Herbert. Asst. Loc. Engr., Cinn., Ky. & Va. Ry. Co., Lawrence, Kans.	Mar. 5, 1907

JUNIORS E-F

	Date of Membership.
EAMES, HORACE LOVELL. Engr., Madeira-Mamoré Ry. Co., Manãos, Brazil	Jan. 7, 1908
EARL, AUSTIN WILLMOTT. 743 Twenty-first St., San Diego, Cal	Dec. 1, 1908
EARLE, FRANK HASBROUCK, JR. 163 North 7th St., Newark, N. J	Dec. 4, 1906
EASTON, RUSSELL BURNS. Aberdeen, S. Dak	Mar. 3, 1908
EBERSPACHER, FRED. U. S. Junior Engr., U. S. Engr. Office, Vicksburg, Miss	Mar. 2, 1909
EDGERTON, GLEN EDGAR. 2d Lieut., Corps of Engrs., U. S. A., 1810 I St., N. W., Washington, D. C	Nov. 8, 1909
EDMUNDSON, HAROLD BOWEN. Care, State Board of Public Rds., Providence, R. I	Nov. 30, 1909
EDWARDS, DEAN GRAY. Asst. Engr., New York Board of Water Supply, Walden, N. Y	Nov. 1, 1904
EITZEN, ARTHUR ROBERT. Columbia, Mo	Sept. 6, 1904
ELAM, WILLIAM EARLE. Care, Miss. Levee Board, Greenville, Miss	Feb. 6, 1906
ELLSWORTH, LINCOLN. Hudson, Ohio	May 5, 1908
ELTINGE, ORVILLE LAMONT. P. O. Box 27, Fort Leavenworth, Kans	Jan. 3, 1907
EMORY, LLOYD TILGHMAN. Gen. Supt., Kaolin Min. Co., 706 Franklin Bank Bldg., Philadelphia, Pa	Oct. 5, 1909
ERDMANN, EARL EDWIN. Bridge Insp., C., M. & P. S. Ry., 1618 East Lake Ave., Seattle, Wash	July 1, 1909
ESTABROOK, GEORGE MITCHELL. With C. W. Leavitt, Jr., 220 Broadway, New York City	Feb. 4, 1908
ESTEN, HOWARD FOSS. 128 Cedar St., Pawtucket, R. I	Jan. 2, 190
EWING, WILLIARD REA. 2405 S. Ridgeway Ave., Chicago, Ill.	Oct. 31, 1905
FARLEY, MARCUS MARTIN. Constr. Dept., Tennessee Coal, Iron & R. R. Co., Birmingham, Ala	Sept. 4, 190
FAUCETTE, WILLIAM DOLLISON. Asst. Engr., Chf. Engr.'s Office, Seaboard Air Line Ry., Portsmouth, Va	Jan. 6, 190
FEIGEL, JOHN HENRY. Asst. Engr., Buffalo Southern Ry., Care, Frederick K. Wing, 910 White Bldg., Buffalo, N. Y.	Oct. 6, 1908
FELGENHAUER, FRANK JOHN. Engr., E. Felgenhauer's Sons, Steel Constr. (Res., 1439 Dean St.), Brooklyn, N. Y.	May 4, 1909
FERGUSON, LEWIS REPP. Prof. of Mathematics, Temple Univ.; Cons. Engr., 1330 Land Title Bldg., Philadelphia, Pa.	Aug. 31, 1909
FERRIER, JOSEPH JAMES. Office Engr., S. P. Co., 1110 Flood Bldg., San Francisco, Cal	Dec. 3, 1907
FERTIG, JEROME HENRY. Asst. Engr., U. S. Reclamation Service, Montrose, Colo	Oct. 2, 1906
FEUSTEL, ROBERT MAXIMILIAN. Civ. Engr. Insp., Wisconsin R. R. Comm., Madison, Wis	May 4, 1909

	Date of Membership.
IELD, Clesson Herbert. 3719 Locust St., Philadelphia, Pa. (Res., 436 Torrey St., Brockton, Mass.)	June 1, 1909
INCH, James Kip. With List & Rose, 639 West 51st St. (Res., 306 West 93d St.), New York City	June 4, 1907
INCH, Stanley Phister. 2306 San Antonio St., Austin, Tex.	Oct. 30, 1906
ISCHER, Guillermo Gustavo. Chf. Engr., Public Works of the Provincial Govt., Santa Clara, Cuba	Feb. 2, 1904
ISHER, Wilbur Howard. Asst. Engr., Twin Falls Salmon River Land & Water Co., P. O. Box Y, Twin Falls, Idaho.	Dec. 6, 1904
ITZRandolph, William Sheppard. Sloatsburg, N. Y.	April 3, 1906
ORD, Harry Clifford. 417 West 150th St., New York City	Mar. 6, 1906
ORD, Howard Carlton. Iowa State Coll., Ames, Iowa	Sept. 1, 1908
ORSYTH, Harold Frederick. Highway Commr.'s Office, Olympia, Wash	Mar. 2, 1909
OSS, James Calvin, Jr. Asst. Engr., Hawaiian Irrig. Co., Kukuihaele, Hawaii	April 6, 1909
OSS, John Harrison. Instr., Civ. Eng. Dept., Leland Stanford, Jr., Univ., P. O. Box 65, Palo Alto, Cal	Dec. 1, 1903
OSTER, Herbert Bismarck. San. Engr., Peoples Water Co., Dept. of Sanitation, Civ. Eng. Bldg., Univ. of California, Berkeley, Cal	Sept. 3, 1907
OULDS, Roberts Shepherd. Asst. Engr., Phœnix Bridge Co., 216 Morgan St., Phœnixville, Pa	Feb. 5, 1907
OWLER, Frederick Hall. Civ. and Hydr. Engr., 221 Kingsley Ave., Palo Alto, Cal	April 3, 1906
OX, Charles Louis. Asst. Supt., Penna. Water Co., 701 Wood St., Wilkinsburg, Pa	May 5, 1903
RAZER, James Stanley. 56 Clark St., Brooklyn, N. Y.	Jan. 2, 1906
RAZER, Joseph Heckart. Casilla No. 53, Oruro, Bolivia	Mar. 31, 1908
RENCH, Roger DeLand. Asst. Engr., National Concrete Constr. Co., 54 Board of Trade, Louisville, Ky	Mar. 6, 1906
RYER, Henry Le Roy. 131 Mercer St., Trenton, N. J.	April 3, 1906
AIGER, Frank Millard. 66 Brookside Ave., Mt. Vernon, N. Y	Jan. 7, 1908
ALVIN, James Augustine. Archt. and Civ. Engr. (Galvin & Clarke), 111 South 2d Ave., Mechanicsville, N. Y.	Sept. 3, 1907
ARDNER, Harry Carter. Instr., Civ. Eng., Univ. of Pennsylvania, 3721 Locust St., Philadelphia, Pa	July 1, 1909
ARRIGUES, Henry Haydock. Supervisor No. 2, Allegheny Div., P. R. R., Kittanning, Pa	Oct. 31, 1905
ARVIN, Edgerton Chester. U. S. Engr. Office, Savannah, Ga.	Dec. 3, 1907
AST, E. Albert. Deputy Surv. and Structural Engr. for Hamilton County; Res., 528 Considine Ave., Cincinnati, Ohio	Oct. 6, 1903

	Date of Membership.
Gates, Marshall DeMotte. Asst. Div. Engr., Southern Div., Chic., Gt. West. R. R., Des Moines, Iowa	Mar. 31, 1908
Gay, Robert Walter. Asst. Supt. of Constr., Hunt & Hunt, Archts., Port Washington, N. Y.	Oct. 6, 1903
Gearhart, Heber Gossler. Draftsman with McClintic-Marshall Constr. Co., Rankin, Pa.	Nov. 5, 1907
Germer, Wilhelm Eduard. Hennebique Constr. Co., 1170 Broadway (Res., 352 West 22d St.), New York City	Aug. 31, 1909
Gifford, George Hoag. Engr. and Contr., 352 Fulton St., Jamaica, N. Y.	Feb. 5, 1907
Gilland, Thomas Omar. 2029 Ontario St., Tioga, Philadelphia, Pa.	Sept. 4, 1906
Gillelen, Frank. Civ. and Min. Engr., 604 Wright & Callender Bldg., Los Angeles, Cal.	May 1, 1906
Gillham, Philip Dakin. Mgr., Buffalo Dist. Office, Corrugated Bar Co., Blasdell, N. Y.	Oct. 30, 1906
Gilman, Charles. 1228 Lenox Ave., Plainfield, N. J.	Dec. 6, 1904
Gilmore, Alvin Leroy. 318 West 57th St., New York City	April 6, 1909
Giquel, Rafael Sanchez. Engr. in Chg., Central Highway, Havana Province, Calle 6 No. 18 Vedado, Havana, Cuba	Feb. 4, 1908
Goodman, Harry Minott. 1410 Milvia St., Berkeley, Cal.	June 4, 1907
Goodrich, Thomas MacLenathen. Archt. and Cons. Engr. (Goodrich & Goodrich), 322 Failing Bldg., Portland, Ore.	Sept. 3, 1907
Goodwin, Irving Dean. 1213 Eighth St., Des Moines, Iowa	Dec. 3, 1907
Gotwals, John Carl. Stillwater, N. Y.	May 5, 1908
Gould, Chester Mason. Asst. Engr., Board of Water Supply, New York City, Cold Spring, N. Y.	April 6, 1909
Gould, John Warren Du Bois. 122 East 34th St., New York City	Oct. 7, 1902
Graham, Germain Paul. 280 Quail St., Albany, N. Y.	Nov. 8, 1909
Graham, Leo Daniel. Care, U. S. Reclamation Service, St. Ignatius, Mont.	June 1, 1909
Gram, Ralph Samuel. 411 Ludington Ave., Menominee, Mich.	Mar. 3, 1908
Gray, Harold Farnsworth. 2540 Benvenue Ave., Berkeley, Cal.	Jan. 4, 1910
Gray, John Colin. Asst. Engr., Bureau of Highways, Borough of Brooklyn, Room 19, Municipal Bldg., Brooklyn, N. Y.	June 4, 1901
Greathead, John Francis. Leveler, Barge Canal Office, Delta, Oneida Co., N. Y.	Mar. 3, 1908
Greeley, Samuel Arnold. Care, City Engr., City Hall, Milwaukee, Wis.	Feb. 5, 1907
Green, Clarence Jasper. 239 S. 12th St., Ann Arbor, Mich.	Sept. 1, 1908
Greene, Francis Ingraham. 128 Broad St., Providence, R. I.	Sept. 4, 1906
Greene, Lloyd Woolsey. 132 East 8th St., Oswego, N. Y.	Sept. 1, 1908
Greenlaw, Ralph Weller. Asst. Engr., Board of Water Supply of New York City, Cold Spring, N. Y.	May 3, 1904
Gregson, Alvero Charles. 162 Willett Court, Jamaica, N. Y.	May 4, 1909

	Date of Membership.
Griffin, Augustus. Engr. and Supt., Modesto Irrig. Dist., Modesto, Cal.	Oct. 30, 1906
Grindrod, Irvin Sutton. 33d and Clearfield Sts., Philadelphia, Pa.	Feb. 2, 1909
Gross, Charles Aaron. Structural Steel Salesman, Bethlehem Steel Co., 111 Broadway, New York City	Sept. 1, 1908
Gross, Joseph Watson. Engr., Tarr Min. Co., Smartsville, Cal.	Sept. 1, 1908
Halcombe, Norman Marshall. Care, The Atlantic, Gulf & Pacific Co., Monadnock Bldg., San Francisco, Cal	Sept. 3, 1907
Hale, Herbert Miller. Asst. Engr., Board of Water Supply, New York City, High Falls, N. Y	Nov. 1, 1904
Hall, Hubert Harry. 917 Fourteenth St., San José, Cal	April 30, 1907
Hall, Julius Reed. Care, Strauss Concrete & Bascule Bridge Co., 902 Fort Dearborn Bldg., Chicago, Ill	June 6, 1905
Hall, Robert Elliot. (Aldrich & Hall), Room D, Seward Bldg., Auburn, N. Y	Sept. 6, 1904
Hall, Warren Esterly. Div. Engr., Porto Rico Irrig. Service, Guayama, Porto Rico	Nov. 5, 1907
Halsey, Wallace Haynes. Bridge Hampton, N. Y	Jan. 7, 1908
Hamilton, Edward Parmelee. With Cuban Eng. & Contr. Co., Arsenal 2, Havana, Cuba	April 6, 1909
Hamlin, Horace Parlin. Designing Engr., Raymond Concrete Pile Co., 140 Cedar St. (Room 1309), New York City	June 6, 1905
Hammer, Robert Henry. 205 Congress St., Brooklyn, N. Y	Jan. 7, 1902
Hanavan, William Lawrence. Asst. Engr., Board of Water Supply, New York City, Walden, N. Y	Dec. 6, 1904
Hancock, Henry Sydney, Jr. City Engr., Fort William, Ont., Canada	Oct. 6, 1903
Hand, Richardson. 84 South St., Wilkes-Barre, Pa	Jan. 3, 1907
Hardesty, Shortridge. 608 E. 9th St., Kansas City, Mo	Sept. 1, 1908
Harding, Sidney Twichell. 1557 Hillside Ave., Wichita, Kans.	Sept. 5, 1905
Harper, Frederick Clayton. Care, Dept. of Civ. Eng., State Univ. of Iowa, Iowa City, Iowa	April 30, 1907
Harper, Sinclair Ollason. Asst. Engr., U. S. Reclamation Service, Grand Junction, Colo	Mar. 31, 1908
Harrison, Russell Edwin. 98 Ransom St., Grand Rapids, Mich	Oct. 30, 1906
Harvey, Michael Smith. Auburn, Ala	April 30, 1907
Harwi, Solomon Jacob. Head of Marine Dept., The Babcock & Wilcox Co., Bayonne, N. J	Dec. 4, 1889
Haselton, Gage. Asst. Engr., S. P. Co., 247 Stout St., Portland, Ore	May 3, 1904
Haselwood, Fred Willis. Asst. Engr., West. Pac. Ry. Co., 903 Filbert St., Oakland, Cal	Jan. 3, 1907

	Date of Membership.
Hastings, Hudson Bridge. Asst. Prof., Dept. of Surveying and Drawing, Bowdoin Coll., Brunswick, Me	Oct. 5, 1909
Hatch, Everett Hamilton. 1276 California St., San Francisco, Cal	Nov. 5, 1907
Hatch, Frederick Nathaniel. Care, Engr., M. of W., Vandalia R. R., Logansport, Ind	June 4, 1907
Hathaway, Clifford Murray. Draftsman, R. I. State Board of Public Roads, 50 Park St., Providence, R. I	Sept. 1, 1908
Hawley, Charles Burridge. Ishpeming, Mich	May 4, 1909
Hawley, Charles Ray. Engr., The Midland Bridge Co., Harrisonburg, La	Feb. 5, 1907
Hayes, Charles Edward. Supt. of Constr., U. S. Reclamation Service, Babb, Mont	Mar. 6, 1906
Hayes, Ferdinand Eugene, Jr. With Jefferson County Constr. Co., Room 312, Coleman Bldg., Louisville, Ky	Feb. 4, 1908
Hayman, Edgar Thomas. Road Engr., Anne Arundel County, Annapolis, Md	Aug. 31, 1909
Haywood, Charles Ellsworth. Draftsman, P. T. & T. R. R. Co., 8 Bridge St., New York City	Nov. 8, 1909
Hazen, Richard. 209 State St., Portland, Me	Nov. 8, 1909
Hedden, Everett Burr. Asst. City Engr., Reading, Pa	Oct. 2, 1906
Heilbronner, Leon Cohen. Care, Acme Eng. & Con. Co., Manion Blk., Herkimer, N. Y	Mar. 2, 1909
Hemphill, William Lind. Abbeville, S. C	Oct. 1, 1907
Henley, Robert Dwiggins Monteith. Care, C. A. Morse, Chf. Engr., A., T. & S. F. Ry. Co., Topeka, Kans	Sept. 3, 1901
Henry, Smith Tompkins. Assoc. Editor, *The Engineering Record*, 590 Old Colony Bldg., Chicago, Ill	Sept. 5, 1905
Hess, John Strider. Box 967, Dawson, Y. T., Canada	Oct. 5, 1909
Hilder, Frazer Croswell. Topographical Draftsman, Office of Indian Affairs, Washington, D. C	Sept. 6, 1904
Hill, Stirling Bryant. 615 Pacific Bldg., Seattle, Wash	Oct. 7, 1902
Hines, Homer Estle. Engr., M. of W., The Virginian Ry. Co., Princeton, Mercer Co., W. Va	May 5, 1908
Hinman, Leroy Race. 714 Ideal Bldg., Denver, Colo	Feb. 5, 1907
Hitt, Rodney. Assoc. Editor, *Electric Railway Journal*, 239 West 39th St., New York City	Sept. 5, 1905
Hodgman, Burt Bradley. Gen. Supt., National Water Main Cleaning Co., 61 Park Row, New York City	Sept. 5, 1905
Hogan, John Philip. Asst. Engr., Board of Water Supply, New York City, High Falls, N. Y	Dec. 6, 1904
Hohl, Leonard Louis. Care, Pacific Gas & Elec. Co., East Auburn, Cal	Sept. 4, 1906
Hoisington, Henry Martyn. Care, Am. Bridge Co., Ambridge, Pa	Feb. 4, 1908

	Date of Membership.
Holbrook, Arthur Raymond. Asst. Engr. Designer, Board of Water Supply of New York City; Address, New Paltz, N. Y.	April 2, 1907
Holbrook, Winfield. Res. Engr., Beaver Land & Irrig. Co., Penrose, Colo.	Mar. 3, 1908
Holland, Howard Kingsbury. 207 New Eng. Bldg., Ann Arbor, Mich.	June 1, 1909
Holloway, Arthur Power. Asst. Night Foreman of Blooming Mill and Skelp Mills, La Belle Iron Works, Steubenville, Ohio	Oct. 5, 1909
Holmes, Robert Leslie. Asst. Engr., Tex. & Pac. Ry., Boyce, La.	Oct. 1, 1907
Hopper, John Jacob. Civ. Engr. and Contr., 215 West 125th St., New York City	May 5, 1886
Hopson, Edward Harold. Asst. Engr., Board of Water Supply, New Paltz, N. Y.	May 1, 1906
Horner, Wesley Winans. 5440 Maple Ave., St. Louis, Mo.	Sept. 1, 1908
Horrigan, William James. Pres., Amies Asphalt Co. of Delaware, 405 Ford Bldg., Wilmington, Del.	June 1, 1909
Horton, John William. 1118½ Twenty-fifth St., Sacramento, Cal.	Sept. 1, 1908
Howard, Clement John. Eng. Dept., The Texas Co., Houston, Tex.	Sept. 6, 1904
Howe, Clarence Decatur. Prof. of Civ. Eng., Dalhousie Univ., Halifax, N. S., Canada	Oct. 5, 1909
Howe, Frank Ray. Engr. and Supt., Queensboro Impvt. Co., 66 Jamaica Ave., Flushing, N. Y.	June 1, 1909
Howe, Harry Northrop. Engr. and Contr. (Gardner & Howe), 51 Porter Bldg., Memphis, Tenn.	Dec. 6, 1904
Howes, Cyrus Pierce. Asst. Engr., Mo. Pac. Ry., St. Louis, Mo.	May 4, 1909
Howes, Donald Winthrop. Asst. Engr., Board of Water Supply, New York City; Address, New Paltz, N. Y.	April 4, 1905
Howes, Franklin Johnson. 34 Clinton Ave., Rochester, N. Y.	June 1, 1909
Howes, Ralph Holt. 500 Fifth Ave., New York City	Feb. 2, 1904
Howie, Howard Benson Wilberforce. Asst. City Engr., City Engr.'s Office, Chattanooga, Tenn.	Mar. 6, 1906
Howson, George William, Jr. 1801 Fairview St., South Berkeley, Cal.	Oct. 5, 1909
Huber, Walter Leroy. Civ. Engr. for John Galen Howard, Archt., 604 Mission St., San Francisco, Cal.	April 3, 1906
Hughes, William Richard, Jr. Beaver, Pa.	June 1, 1909
Hull, Gordon Burnett Gifford. Cia. Transvias, Luz y Fuerza de Puebla, Apartado 16, Atlixco, Estado de Puebla, Mexico	July 1, 1909
Humphrey, Frederic Learoyd. Junior Engr., U. S. Reclamation Service, Phœnix, Ariz.	June 4, 1907

	Date of Membership.
Hunter, Leroy Littlefield. With Bureau of Eng., 807 City Hall, Chicago, Ill	Jan. 5, 1904
Huntington, Linn Murdoch. Civ. Engr., Dirección Gen., Dept. de Obras Publicas, Santo Domingo, Santo Domingo	May 2, 1905
Huntsman, Frank C. Macon, Mo	Sept. 5, 1905
Hurdle, Reginald Truman. Engr. for D. H. Freeman & Co. (also Surv. for Dawson County, Mont.), Glendive, Mont.	Oct. 1, 1907
Hutchings, John Bacon, Jr. Archt., 809 Columbia Bldg., Louisville, Ky	Sept. 6, 1904
Hyde, Edward Wyllys, Jr. Room 404, McKinnon Bldg., Toronto, Ont., Canada	Sept. 4, 1906
Irwin, Orlando William. Asst. Chf. Draftsman, L. S. & M. S. Ry., Bridge Dept., Cleveland, Ohio	Sept. 4, 1906
Ives, Howard Chapin. Asst. Prof. of R. R. Eng., Worcester Poly. Inst., Worcester, Mass	Dec. 3, 1901
Jabelonsky, Carl Hugo. Cons. Engr. and Archt., 439 Peyton Bldg., Spokane, Wash	Sept. 1, 1903
Jacobosky, Gilbert Garfield. Civ. and Cons. Engr., 116 Second National Bank Bldg., Wilkes-Barre, Pa	Nov. 5, 1907
Jacobs, Julius Lilien. Supt., Houston Office, James Stewart & Co., Contrs., Houston, Tex	Sept. 1, 1908
Jarvis, Clarence Sylvester. Civ. Engr., Provo Reservoir Co., Provo, Utah	Sept. 4, 1906
Jerrard, Leigh Patterson. 422 W. Dayton St., Madison, Wis.	Oct. 5, 1909
Johnson, David Clayton. Asst. Engr., H. de B. Parsons, 22 William St., New York City (Res., 245 Hewes St., Brooklyn, N. Y.)	Sept. 1, 1908
Johnson, Granville. 79 Bellevue St., Boston, Mass	Mar. 5, 1907
Johnson, Luther Elman. Asst. Engr., U. S. Reclamation Service, Burley, Idaho	Sept. 6, 1904
Johnston, Andrew Crawford. Civ. Engr. with F. W. Bird & Son, East Walpole, Mass	Sept. 1, 1908
Jones, Benjamin Earl. Junior Highway Engr., U. S. Office of Public Roads, Dept. of Agriculture, Washington, D. C.	April 6, 1909
Jones, George Morton. Asst. Chf. Engr., Ga. & Fla. Ry., P. O. Box 236, Augusta, Ga	Sept. 3, 1907
Jones, Grandville Reynard. Chf. Chemist and Asst. Supt., Filtration Plant, Washington, D. C	Jan. 7, 1908
Jones, Irving Paul. Care, U. S. Reclamation Service, North Yakima, Wash	Mar. 5, 1907
Jones, Pusey. Structural Draftsman, Millbrook Co., 65 Beaver St., New York City	Mar. 6, 1906
Joslin, Harold Vincent. Asst. to Chf. Engr., Norfolk & Southern Ry. (Res., 9 Stratford Apartment), Norfolk, Va	April 6, 1909

	Date of Membership.
Jouine, Georges Pierre Ferdinand. U. S. Junior Engr., Box 404, Vicksburg, Miss	Oct. 6, 1908
Kahn, Gustave Edmund. Chf. Engr., Sterling Eng. & Constr. Co.; Chf. Engr., National Eng. & Constr. Co., Caswell Blk., Milwaukee, Wis	Sept. 6, 1904
Karnopp, Edwin Benjamin. Asst. Engr., Panama R. R., Cristobal, Canal Zone, Panama	Jan. 3, 1907
Kellersberger, Arnold Charles. Care, Y. M. C. A., Fort Worth, Tex	Oct. 6, 1908
Kempkey, Augustus, Jr. Asst. Engr., Peoples Water Co., 35 Mountain Ave., Piedmont, Cal	Mar. 31, 1903
Kennedy, Thomas Patrick Berchmans. Engr. and Contr. (Kennedy & Easton); Res., 138 Washington Ave., Albany, N. Y.	May 5, 1908
Ketchum, Morris. 77 East 89th St., New York City	Dec. 4, 1906
Kienle, John Aspin. Chf. Engr., Water Dept. (Res., 829 Jackson St.), Wilmington, Del	April 3, 1906
Kilkenny, Tobias Dillon. 538 Georgia St., Vallejo, Cal	Oct. 6, 1908
King, Arthur Caswell. Asst. Engr., Springfield Water-Works, Mundale, Mass	Sept. 4, 1906
King, Edmund Geddes. Pottsville, Pa	Nov. 8, 1909
King, Eric Ture. Asst. Engr., Board of Water Supply of New York City, Cornwall-on-Hudson, N. Y	Feb. 5, 1907
Kingsley, George. Civ. Engr. and Supt. Constr., Fort Leavenworth, 522 Osage St., Leavenworth, Kans	June 2, 1908
Kirkwood, Howard Camberne. Chf. of Party, P. T. & T. R. R. Co., 530 West 153d St., New York City	Feb. 4, 1908
Knight, Walter Joseph. Engr. for the Gilsonite Constr. Co., 720 Wainwright Bldg., St. Louis, Mo	May 5, 1908
Knutson, George Henry. Draftsman with Gardner S. Williams, Room 205, New Engineering Bldg., Ann Arbor, Mich.	Aug. 31, 1909
Koenig, Louis. Dept. of Docks and Ferries, Pier A, N. R., New York City	Jan. 7, 1908
Kohn, Arthur Hirsh. 21 North Lime St., Lancaster, Pa	Oct. 2, 1906
Krieger, Albert August. 1141 Cherokee Rd., Louisville, Ky	June 1, 1909
Kriegsman, Eugen Frederick. Asst. Engr., Office of City Engr., San Francisco, Cal	May 5, 1908
Lake, Orloff. 2032 State Ave., New Orleans, La	Dec. 1, 1908
Lamb, William Alfred. Dist. Engr., U. S. Geological Survey, Helena, Mont	Nov. 5, 1907
Larimer, Robert Sherman. Wendell, Idaho	June 1, 1909
Layng, Frank Rahn Shunk. Engr. of Track, Bessemer & Lake Erie R. R., Greenville, Pa	April 1, 1902

	Date of Membership.
Lee, Charles Hamilton. Asst. Engr., Los Angeles Aqueduct, Independence, Cal	Jan. 2, 1906
Leeds, Charles Tileston. 1st Lieut., Corps of Engrs., U. S. A., 723 Central Bldg., Los Angeles, Cal	Jan. 3, 1907
Leeuw, Henry. Asst. Supt., Degnon Contr. Co., New Paltz, N. Y	Sept. 5, 1905
Lemcke, Karl Wolfgang. Draftsman, Bridge Dept., Am. Bridge Co., Ambridge, Pa	June 1, 1909
Leonard, Oliver Yeaton. Draftsman, Porto Rico Irrig. Service, Guayama, Porto Rico	Nov. 8, 1909
Lewis, Chester Brooks. Engr., Standard Constr. Co., 1548 First National Bank Bldg., Chicago, Ill	Nov. 5, 1907
Lewis, Wilfred. Care, Lewis & Wiley, Inc., 706 Central Bldg., Seattle, Wash	Dec. 3, 1907
Libbey, James Templeton. With Friday Contr. Co., Pittsburg; Address, Oakmont, Pa	Dec. 5, 1905
Lichtner, William Otto. Asst. to Sanford E. Thompson, Newton Highlands, Mass	Aug. 31, 1909
Lillich, Joseph Thomas. 37 Harmon Ave., Detroit, Mich	Nov. 3, 1903
Lilly, Ridgely Casey. U. S. Junior Engr., 3d Dist., Mississippi River Comm., Box 404, Vicksburg, Miss	Oct. 5, 1909
Lindsay, Richard Lee. Gen. Contr., Municipal Work, 1111 Henry St., Roanoke, Va	Sept. 4, 1906
Lindsley, Thayer. Telluride, Colo	Jan. 3, 1905
Lint, Johannes Adrianus de. District-Inspecteur der Spoorwegdiensten, Oorsprongpark 3, Utrecht, The Netherlands.	Sept. 5, 1905
Lisman, Oliver Cromwell. Care, U. P. R. R. Co., Green River, Wyo	Jan. 7, 1908
Littlefield, Emmett. 60 Maple Ave., Troy, N. Y	Feb. 5, 1907
Lord, Harold. Supt. of Constr., Office of Light-House Engr., Honolulu, Hawaii	Sept. 3, 1907
Loughran, Harold Scott. 14 Lawton St., New Rochelle, N. Y.	Jan. 2, 1906
Loughran, James Francis. County Engr., Ulster Co., Court House, Kingston, N. Y	Feb. 4, 1908
Lowry, John, Jr. Contr. and Builder, 160 Fifth Ave., New York City	Feb. 4, 1908
Lubarsky, Louis Henry. Civ. Engr. and City Surv., 1400 Fifth Ave., New York City	Feb. 5, 1907
Ludlow, Justin Wyman. Asst. Prof. of Structural Eng., Lewis Inst., Chicago, Ill	April 5, 1904
Lundgren, Emil Leonard. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands	Feb. 4, 1908
Lush, Cuyler Warfield. Rye, N. Y	Feb. 4, 1908
Lydston, Walter Edward. Hotel Bartol, Huntington Ave., Boston, Mass	April 4, 1905

	Date of Membership.
Lynch, Edwin Lewis. Third Asst. Engr., Dept. of Public Works (Res., 23 Emerson St.), Portland, Me	Feb. 5, 1907
Lynde, Clifford. Asst. Engr., Board of Water Supply, City of New York, Walden, N. Y	Dec. 1, 1908
Lynn, Henry Hudson Edwin. 348 West 51st St., New York City	May 5, 1908
Macfarlane, Arthur Keddie. Care, The Benicia Iron Works, Benicia, Cal	Oct. 5, 1909
MacIlvaine, Francis Shippen. P. T. & T. R. R., Seventh Ave. and 32d St., New York City	Mar. 3, 1908
Mackall, John Nathaniel. Asst. Engr., Md. Geological Survey and State Roads Comm., Johns Hopkins Univ., Baltimore, Md	Aug. 31, 1909
Macklem, Norris Raymond. Grosse Ile, Mich	April 2, 1907
McCandliss, Wallace Highland. 3334 Chestnut St., Philadelphia, Pa	Jan. 7, 1908
McClave, Stephen Wood, Jr. With McClave & McClave, Borough Hall, Cliffside Park, N. J	Jan. 3, 1907
McClintock, James Robinson. Care, Hering & Fuller, 170 Broadway, New York City	Oct. 2, 1906
McCrory, Sol. 518 Sixth St., Charleston, Ill	Oct. 6, 1903
McCrory, Thomas George. Bridge Insp., Ore. Short Line R. R. and S. P. R. R. East of Sparks, Nev., Pocatello, Idaho	Dec. 1, 1908
McDaniel, George Glenn. U. S. Deputy Mineral Surv., Mazuma, *via* Lovelocks, Nev	Mar. 5, 1907
McKinney, Francis William. 60 Wall St., New York City	Mar. 31, 1908
McMenimen, William Vincent. 172 Fairview Ave., Jersey City, N. J	April 30, 1907
McNeil, Arthur James. Asst. Engr., Assoc. Pipe Line Co., Tracy, San Joaquin Co., Cal	Mar. 6, 1906
McNeil, Norman Charles. 258 Audubon Ave., New York City.	May 5, 1908
Madigan, Francis William. Box 1007, Lyons, N. Y	Oct. 6, 1908
Magruder, Frank Cecil. Asst. Engr., U. S. Reclamation Service, Orman, S. Dak	Sept. 6, 1904
Malcomson, Alfred Sidney. Municipal and Civ. Engr. (Smith & Malcomson), 37 Railroad Ave., Freeport, N. Y	Mar. 3, 1908
Malony, Walden Le Roy. Asst. to City Engr., Bridge Dept., P. O. Box 1078, Spokane, Wash	Aug. 31, 1909
Malsbury, Omer Evert. Instrumentman, P. R. R., Ancon, Canal Zone, Panama	Feb. 5, 1907
Marsh, Emmett Lincoln. Asst. Engr., S. P. Co., Box 21, Bowman, Cal	Mar. 5, 1907
Marsh, Francis Beal. Asst. Engr., Board of Water Supply, 299 Broadway, New York City	Oct. 2, 1906

	Date of Membership.
MARTINEZ, ROLANDO ARNOLDO. Mass. Inst. Tech., Students Box 82, Boston, Mass	Dec. 1, 1908
MAYELL, ALBERT JEFFERSON. Asst. Engr., Public Service Comm. for the First Dist., 154 Nassau St. (Res., 322 East 198th St.), New York City	Mar. 1, 1904
MAYNARD, HENRY WARNER. Aid, U. S. Coast and Geodetic Survey, Washington, D. C	Dec. 3, 1907
MEHREN, EDWARD JOHN. Associate Editor, *The Engineering Record*, 239 West 39th St., New York City	Oct. 30, 1906
MENDENHALL, HERBERT DRUMMOND. Lakeland, Fla	Sept. 4, 1906
MERRILL, ROBERT HALL. Asst. Engr., Barge Canal Office, Medina, N. Y	May 3, 1904
MERRIMAN, RICHARD MANSFIELD. Central Valley, N. Y	Jan. 3, 1907
MERRITT, CHARLES EDWARD. 114 South Massey St., Watertown, N. Y	Jan. 4, 1910
METZGER, FRITZ LOUIS. Civ. Engr., Cummings Structural Concrete Co., Pittsburg, Pa	Feb. 6, 1906
MIETH, RICHARD ELAM. Contr. Engr., Standard Bridge Co., Omaha, Nebr	May 1, 1906
MILLARD, CURTISS. 215 Fredonia Ave., Peoria, Ill	April 3, 1889
MILLER, CROSBY. Care, B. & C. Dept., Pennsylvania Steel Co., Steelton, Pa	Jan. 7, 1908
MILLER, FRITZ. Instrumentman, Utah Copper Co., Utah Copper Mine Office, Bingham Canyon, Utah	June 4, 1907
MILLER, HAROLD EDMUND. Chf. Draftsman, Rhode Island State Board of Public Roads, 110 Dexter St., Providence, R. I	Oct. 1, 1907
MILLER, HENRY LANARK. Comisión de Estudios del Rio Tunuyan, San Carlos, Mendoza, Argentine Republic	June 4, 1907
MILLER, HUGH. 93 Main St., Potsdam, N. Y	Nov. 30, 1909
MILLS, ADELBERT PHILO. Asst. Prof. of Civ. Eng., Coll. of Civ. Eng., Cornell Univ., 407 N. Aurora St., Ithaca, N. Y	Sept. 3, 1907
MISCHKE, ALEXANDER. Engr. of Ways of Communication; Prin. Asst. Chf. Engr., Warsaw Govt. Terminal Ry. Constr., 16 Jouravlinaya, Warsaw, Russia	Oct. 5, 1909
MITCHELL, WILLIAM WASHINGTON. Res. Engr., Connell-Northern Ry., Warden, Wash	April 2, 1907
MONTERO, JULIO DANIEL. Ingeniero de 1a Clase, Encargado del Negociado de Calles, Parques y Transportes, Departamento de Obras Públicas, Jefatura de la Ciudad de la Habana, Neptuno 187, Havana, Cuba	Oct. 1, 1907
MOORE, JAMES GATES. U. S. Naval Station, Key West, Fla	Aug. 31, 1909
MOORE, STANLEY WALLACE. Care, Bureau of Public Works, Manila, Philippine Islands	July 1, 1909
MORAN, ROBERT BRECK. 661 Waverley St., Palo Alto, Cal	Sept. 1, 1908

	Date of Membership.
MORRISON, CHRISTOPHER GEORGE. Asst. Engr., Dist. No. 8, Bureau of Public Works, Manila, Philippine Islands	Oct. 5, 1909
MOSER, ALBERT LEO BRECHT. Cripple Creek, Colo	Jan. 3, 1907
MOULTON, OREN MCKENNEY. Gorham, Me	April 2, 1907
MYERS, GEORGE HIGGINS. Care, Dietrich & Goetz, Tucson, Ariz.	June 1, 1909
NEAL, CLARENCE ADKINS. Secy., Union Bridge & Constr. Co., 903 Sharp Bldg., Kansas City, Mo	Dec. 6, 1904
NELSON, JABEZ CURRY. Engr. with Ford, Bacon & Davis, 115 Broadway, New York City	Oct. 1, 1907
NEUHARDT, EDWIN. Instrumentman, City Engr.'s Office, City Hall, Memphis, Tenn	Nov. 8, 1909
NEWTON, GEORGE CHENEY. Engr., Newton Eng. Co., 1211 Majestic Bldg., Milwaukee, Wis	Feb. 4, 1908
NICHOL, HENRY SCHELL. Care, Post & McCord, 44 East 23d St., New York City	Jan. 2, 1906
NICHOLS, JOHN ROBERT. Asst. in Civ. Eng., Harvard Univ., 82 Avon Hill St., Cambridge, Mass	June 1, 1909
NICOLAYSEN, ALBIN GEORG. 876 Irvine St., Bronx, New York City	Dec. 1, 1908
NIKIRK, FRANK AUSTIN. 60 W. Virginia St., San José, Cal	April 2, 1907
NIKOLITCH, MILAN. Designing Engr., S. P. Co. (Res., 224 Twenty-first Ave., R. D.), San Francisco, Cal	Sept. 1, 1908
NORDWELL, ALFRED WORCESTER. 20 Shepard St., Cambridge, Mass.	June 1, 1909
NOYES, STEPHEN HENLEY. 15 Francis St., Newport, R. I	Oct. 1, 1907
O'BRIEN, DANIEL BERNARD. Engr., O'Brien & Hoolihan Contr. Co., Syracuse, N. Y	April 3, 1906
O'BYRNE, LEO CHARLES. 2545 Washington Boulevard, Chicago, Ill.	Feb. 5, 1907
OSBORN, KENNETH HOWARD. Transitman, New York State Railways, 267 State St., Rochester, N. Y	Oct. 5, 1909
OTTOSEN, PETER HILL. Lieut., Coast Artillery Corps, U. S. A., Fort Ward, Wash	Oct. 6, 1908
OWEN, KENNETH DUNHAM. Montclair, N. J	Feb. 6, 1906
PAGON, WILLIAM WATTERS. 1301 St. Paul St., Baltimore, Md.	Sept. 3, 1907
PAINE, GEORGE HEBARD. The Continental Signal Co., 46 East Van Buren St., Chicago, Ill	Nov. 5, 1890
PARKER, JAMES LAFAYETTE. 116 Nassau St., Room 901, New York City	April 2, 1907
PARKER, KINGSBURY EASTMAN. 841 Monadnock Bldg., San Francisco, Cal	May 5, 1908
PARSONS, AUGUSTUS TABER. Bank of Bakersfield Bldg., Bakersfield, Cal	June 5, 1906

	Date of Membership.
Paterson, Charles Judson. Box 982, Oklahoma, Okla	Feb. 1, 1910
Patterson, Earl. U. S. Reclamation Service, Selden, Dona Ana Co., N. Mex	April 30, 1907
Patterson, Irving Wooster. Insp., Rhode Island State Board of Public Roads, 175 Thayer St., Providence, R. I.	Jan. 4, 1910
Payrow, Harry Gordon. Eng. Dept., Waterbury, Conn.; Address, Box 41, R. F. D. No. 1, Thomaston, Conn	Feb. 4, 1908
Peabody, Lionel Henry, Jr. Associate with O. Perry Sarle, 146 Westminster St., Providence, R. I.	Feb. 6, 1906
Peck, Charles Franklin. Asst. on Engr. Corps, Penna. Lines West, 1013 Penn Ave., Pittsburg, Pa	April 2, 1907
Peck, John Calvin. Supt. of Constr. for Wm. F. Holding, Gen. Contr., on New U. S. Post Office, Hudson, N. Y.	Sept. 1, 1908
Pendlebury, Edward. Asst. Engr., Public Service Comm., 150 Nassau St., New York City (Res., 26 Franklin Pl., Arlington, N. J.)	Oct. 2, 1906
Pendleton, David Elliott. Care, H. & T. C. R. R., Ennis, Tex.	Jan. 2, 1906
Perry, John Prince Hazen. Mgr., Contr. Dept., Turner Constr. Co., 11 Broadway, New York City	Nov. 1, 1904
Perry, Lynn Elwood. Dept. of Public Works, Bureau of Surveys, Philadelphia, Pa	Sept. 1, 1908
Peters, John Marvin. Asst. Engr., Mo. Pac.-Iron Mountain System; Res., 4516 McPherson Ave., St. Louis, Mo	May 1, 1906
Peterson, Garfield Christian. Care, Cuba Eastern R. R., Guantanamo, Cuba	Oct. 2, 1906
Pierce, Paul Leon. Care, J. G. White & Co., 43 Exchange Pl., New York City	Jan. 7, 1908
Pike, Ralph Ashur. 127 N. High St., Mt. Vernon, N. Y.	Mar. 6, 1906
Pill, Leon Morley. (Taylor & Pill), American Falls, Idaho.	Aug. 31, 1909
Pillet, Frederick Fischer. First Asst. Engr., Board of Public Works, Mobile, Ala	June 2, 1903
Plummer, Horace Edwards. 542 Greenwood Ave., Portland, Ore	April 30, 1907
Porter, Harry Franklin. 1157 Park Ave., Bridgeport, Conn.	Nov. 5, 1907
Porter, John Endicott. Designer in Office of Engr. of Structures, N. Y. C. & H. R. R. R.; Res., 6 Ashburton Pl., Yonkers, N. Y.	Sept. 1, 1903
Potter, Edwin James. Bridgeton, R. I.	Oct. 1, 1907
Powell, William Jenner. Box 153, Baird, Tex	Jan. 2, 1906
Pritchard, John Charles. Asst. Engr., Water Dept., 4245 Evans Ave., St. Louis, Mo	Sept. 1, 1908
Pruett, Grover Cleveland. Care, C., M. & St. P. Ry. Co., Miles City, Mont	Mar. 2, 1909
Querbach, Earl. Instr. in Bridge Eng., Univ. of Missouri, 717 Missouri Ave., Columbia, Mo	Dec. 4, 1906

	Date of Membership.
Rackle, Oscar William. 94 Angell St., East Side Station, Providence, R. I.	Sept. 4, 1906
Ramsdell, Robert Leroy. 1215 Caroline St., Houston, Tex.	Oct. 6, 1908
Randolph, Robert Isham. Secy., Internal Impvt. Comm. of Illinois, 164 Dearborn St., Chicago, Ill.	July 1, 1909
Raschbacher, Harry George. Res. Engr., The Arnold Co., Box 191, Canon City, Colo.	May 2, 1905
Rathbun, John Charles. Chf. Draftsman, State Highway Commrs. Office, Olympia, Wash.	Oct. 6, 1908
Ray, David Heydorn. Instr., Dept. of Physics, Coll. of the City of New York, 2273 Creston Ave., Bronx, New York City.	Oct. 7, 1902
Reed, Carl Sweetland. 30 Church St., New York City.	Mar. 31, 1908
Reed, Frank Edward. State Dept. of Highways; Address, 63 Canvass St., Cohoes, N. Y.	April 6, 1909
Reed, Ralph John. 1012 Security Bldg., Los Angeles (Res., Whittier), Cal.	Sept. 1, 1908
Regester, Henry Slicer, Jr. Asst. Engr., Sewerage Comm., 908 American Bldg., Baltimore, Md.	Jan. 7, 1908
Reimann-Hansen, Robert Louis. Draftsman, B. & O. R. R., 147 Wilson Ave., Morgantown, W. Va.	Oct. 3, 1905
Rennell, Henry Hurd. Res. Engr., Central New England Ry., R. F. D. No. 4, Arlington, N. Y.	Mar. 3, 1908
Reynolds, Robert Albert. 170 Blain Ave., Detroit, Mich.	May 5, 1908
Rhett, Edmund Moore. Elec. Engr., Cent. of Ga. Ry. Co., Savannah, Ga.	Nov. 4, 1902
Rice, John Marie Thomas. Div. Engr., Bureau of Filtration, Dept. of Public Works (Res., 5307 Butler St.), Pittsburg, Pa.	April 2, 1907
Rice, Rowland Grenville. 192 Summer St., Stamford, Conn.	Mar. 5, 1907
Rich, Melvin S. 1448 Harvard St., Washington, D. C.	Sept. 5, 1905
Rich, Wilder Meloy. U. S. Engr. Office, Sault Ste. Marie, Mich.	Sept. 3, 1907
Richardson, Jeremiah Daniels. 60 Vine St., Corona, N. Y.	Jan. 7, 1908
Riegel, Ross Milton. 275 Briggs St., Harrisburg, Pa.	Mar. 5, 1907
Rindsfoos, Charles Siesel. With The Foundation Co., 115 Broadway, New York City.	April 2, 1907
Roberts, Harold Whitney. With Rapid Transit Subway Constr. Co., 165 Broadway (Res., 101 West 89th St.), New York City.	Oct. 5, 1909
Roberts, Vincent. 225 Fifth Ave., New York City.	Mar. 6, 1906
Robertson, Avalon Graves. Asst. Engr., Changuinola Ry., United Fruit Co., Bocas del Toro, Panama.	Oct. 6, 1908
Robinson, Ernest Franklin. U. S. Engr. Office, Room 710, Army Bldg., New York City.	Mar. 3, 1908
Robinson, Ward Reid. Reinforced Concrete Designer, C., M. & St. P. Ry., 5531 Monroe Ave., Chicago, Ill.	April 2, 1907
Rogers, Thomas Farwell. 511 Pierce St., Monterey, Cal.	Mar. 5, 1907

	Date of Membership.
Rollins, Andrew Peach. Eagle Lake, Tex	May 4, 1909
Rommel, William Gustave. Asst. Engr. with T. C. Hatton, 233 Broome St., Wilmington, Del	Oct. 2, 1906
Rossell, Paul Francis. Care, Capt. Lytle Brown, Corps of Engrs., U. S. A., Wheeling, W. Va	Mar. 2, 1909
Rowe, Wilfred Lincoln. 714 Van Buren St., Milwaukee, Wis.	Mar. 31, 1908
Russell, Alexander Allen MacVicar. Saratoga, Santa Clara Co., Cal	May 5, 1908
Russell, Alexander Stuart. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands	Oct. 6, 1908
Ryan, Richard R. Designing Engr., Office of Territorial Engr., Phœnix, Ariz	Dec. 3, 1907
Ryan, Walter J. Res. Engr., N. P. Ry., Cannon Ball, N. Dak. (Res., York, Nebr.)	May 5, 1908
Sackett, Arthur Johnson. Instrumentman, P. T. & T. R. R. Co., 140 Third St., Long Island City, N. Y	Mar. 1, 1904
Sanger, Walter Max. Office Engr., Sud Pacifico de Mexico R. R., Care, S. P. Co., Cumuripa, Sonora, Mexico	May 5, 1908
Saucedo, Vicente. Res. Engr., Monterrey Water-Works and Sewer System, P. O. Box 291, Monterey, N. L., Mexico	Oct. 6, 1903
Sauer, Alfred Francis. Transitman, C. R. R. of N. J., Chf. Engr.'s Office, Jersey City (Res., 117 Jacques St., Elizabeth), N. J	Sept. 1, 1903
Sawyer, James Herbert. Address unknown	Mar. 5, 1907
Saxe, Van Rensselaer Powell. Asst. Engr. for Standard Concrete-Steel Co., 415 East 31st St. (Res., 144 East 22d St.), New York City	Feb. 4, 1908
Sayers, Edward Lawrence. With Noble & Woodard, Cons. Engrs., 7 East 42d St., New York City	Feb. 2, 1904
Schlickeisen, Albert August. Address unknown	Dec. 3, 1907
Schmid, Francis Rauch. Designing Draftsman, N. Y. C. & H. R. R. R., 30 Wall St., Bethlehem, Pa	Oct. 6, 1903
Schmid, Robert John. Office of City Engr., Spokane, Wash	Feb. 2, 1909
Schmitt, Jacob. Asst. Engr., Bureau of Highways, 36 Municipal Bldg., Brooklyn, N. Y	June 2, 1903
Schobinger, George. Engr. Insp., Board of Superv. Engrs., Chicago Traction, 181 La Salle St., Chicago, Ill	Oct. 5, 1909
Scholtz, Herman Fred. Care, Erickson Constr. Co., U. S. Navy Yard, Bremerton, Wash	Oct. 30, 1906
Schultz, Charles. Gen. Delivery, Muskogee, Okla	Nov. 1, 1904
Schumann, Carl Julius. With Moller & Schumann Co., Marcy and Flushing Aves., Brooklyn, N. Y	Dec. 2, 1902
Schuyler, Montgomery. 3308 Halliday Ave., St. Louis, Mo	Sept. 1, 1908
Scott, John Kuhn. Care, Am. Water-Works & Guarantee Co. (Res., 5470 Block St.), Pittsburg, Pa	Oct. 1, 1907

	Date of Membership.
Scott, Walter Vanderbelt. 249 Whitney Pl., Buffalo, N. Y.	Nov. 8, 1909
See, George Corliss. Asst. Engr., Dept., State Engr. and Surv., N. Y. State, Troy, N. Y.	Sept. 3, 1907
Seeley, Henry Arthur. Insp., Reinforced Concrete Bridge, Pequonocks River at Bridgeport, 334 Fairfield Ave., Bridgeport, Conn.	Jan. 4, 1910
Selby, Oscar Ellsworth. Engr. of Bridges and Structures, C., C., C. & St. L. Ry., Cincinnati, Ohio	Mar. 4, 1891
Selmer, William Lee. Hamilton Park, New Brighton, N. Y.	Mar. 31, 1908
Shafer, James Charles Forsythe. Res. Engr. for Truesdell-Fox Co., New York City; Address, Hadlock, Wash.	Oct. 6, 1908
Shankland, Ralph Graham. Supt. of Concrete Const. for E. C. & R. M. Shankland, 1106 The Rookery Bldg., Chicago, Ill.	Nov. 8, 1909
Shelley, Oswald Procter. Engr., The Lilley & Thurston Co., 82 Second St., San Francisco, Cal.	April 5, 1904
Shema, Joseph. Insp. of Bridges, B. & O. R. R., Wheeling, W. Va.	Oct. 3, 1905
Sherman, Arthur Louis. Asst. Engr., Board of Water Supply of N. Y., Y. M. C. A., White Plains, N. Y.	Jan. 4, 1910
Shiebler, Marvin. Gas Engr., 30 Church St., New York City.	June 6, 1905
Shoemaker, Harry. Box 252, Fort Edward, N. Y.	Sept. 3, 1907
Simpson, Charles Randolph. 201 Second St., Huntingdon, Pa.	Feb. 2, 1909
Sims, Harvey Hillyer. 154 Gordon St., Atlanta, Ga.	May 4, 1909
Small, Gilbert. 428 Lexington St., Waltham, Mass.	June 1, 1909
Small, James Hampden, Jr. 526 West 124th St., New York City	Mar. 31, 1903
Smith, Charles Horton. County Engr., 16 East Main St., Middletown, N. Y.	June 4, 1890
Smith, Eliot Nichols. Board of Water Supply, Poughkeepsie, N. Y.	April 2, 1907
Smith, Elroy George. 424 West 146th St., New York City	Sept. 1, 1908
Smith, Ford Cushing. Care, Rev. G. H. Smith, Rhinebeck, N. Y.	April 3, 1906
Smith, Francis Marshall. Asst. Engr., N. P. Ry., Room 27, Second and King Sts., Seattle, Wash.	Jan. 3, 1907
Smith, Joseph. Asst. Engr., Public Service Comm., 23 Flatbush Ave., Brooklyn, N. Y.	Feb. 2, 1909
Smith, Marion deKalb, Jr. 6 Washington Ave., Chestertown, Md.	Oct. 1, 1901
Smith, Robert Mackinlay. 3 Westbourne Terrace, Kelvinside, Glasgow, Scotland	June 6, 1905
Smith, Shaler Gordon. Bridge Dept., B. & O. R. R., Baltimore, Md.	July 1, 1909

	Date of Membership.
Snyder, Hunter Imboden. Care, Lightman, McDonald & Co., Jacksonville, Fla.	Nov. 30, 1909
Spalding, Walter James. Junior Engr., Isthmian Canal Comm., Pacific Div., La Boca, Canal Zone, Panama	Nov. 1, 1904
Speidel, Hugo S. Pres., The David Henry Bldg. Co., Cor. Main and Smith Sts., Paterson, N. J.	Feb. 5, 1890
Spooner, Charles Willett. Prin. Asst. Engr. to Gardner S. Williams, 205 New Engineering Bldg., Ann Arbor, Mich.	Mar. 2, 1909
Sprague, Edwin Loring, Jr. Asst. Engr., Board of Water Supply, Valhalla, N. Y.	May 31, 1904
Squire, Harry Edwin. Engr. for Erickson Const. Co., 924 Highland Ave., Bremerton, Wash.	Jan. 3, 1907
Stanton, Wilbor Dickens. Transitman, Isthmian Canal Comm., Dept. of Eng., Las Cascadas, Canal Zone, Panama	Oct. 2, 1906
Starr, William H. 3 West 8th St., New York City	April 2, 1884
Steegmuller, Charles Albert Augustine. 2859 Briggs Ave., Bronx, New York City	Mar. 6, 1906
Steese, James Gordon. Lieut., Corps of Engrs., U. S. A., The Benedick, Washington, D. C.	Aug. 31, 1909
Stephenson, Grant Thomas. Gen. Supt., Mashek Chemical & Iron Co.; Res. Engr. for The Escanaba & Lake Superior Ry. Co., Wells, Delta Co., Mich.	May 5, 1908
Stewart, Charles Sumner. 5757 Drexel Ave., Chicago, Ill.	Nov. 30, 1909
Stewart, Walter Phelps. U. S. Engr. Office, Nashville, Tenn.	Nov. 8, 1909
Stewart, William James. First Asst. City Engr., Rochester, N. Y.	May 7, 1890
Stiles, Albert Irvine. Asst. Engr., Mo. Pac. Ry., 4643 Delmar Ave., St. Louis, Mo.	Feb. 6, 1906
Stirling, Vincent Reynolds. Care, Prof. S. G. George, Cornell Univ., Ithaca, N. Y.	Oct. 2, 1906
Stone, James Hammond. R. F. D. No. 2, Concord, N. H.	Mar. 31, 1908
Stow, Mulford. Bridge Insp., N. Y., O. & W. Ry., Middletown, N. Y.	Sept. 3, 1907
Stratton, Charles Heywood. Supt. of Constr., U. S. Post Office, Paris, and U. S. Post Office and Court House, Danville, Ill.; Address, 410 W. Court St., Paris, Ill.	Oct. 6, 1903
Strong, Sidney Davis. Junior Engr., U. S. Engr. Office, Sault Ste. Marie, Mich.	Nov. 5, 1907
Strout, Gale Stanley. Palo Alto, Cal.	Mar. 31, 1908
Suarez y Cordoves, Patricio Andres. G. Esquina A 11, Vedado, Havana, Cuba	April 6, 1909
Suttle, Clifford Bradley. 304 North 35th St., Philadelphia, Pa.	Oct. 30, 1906
Sweeney, John Bernard. 703 East Parkway, McKeesport, Pa.	Feb. 4, 1908

	Date of Membership.
SWEESY, THOMAS KING. Engr. of Constr., San Quentin, Cal.; Address, 2520 Cedar St., Berkeley, Cal	Aug. 31, 1909
SWEETLAND, HAROLD ANTHONY. 9 Orchard Ave., Providence, R. I	Oct. 5, 1909
SWENSSON, OTTO JORDAN. Draftsman with McClintic-Marshall Constr. Co., Pittsburg, Pa	Nov. 8, 1909
SWETT, EVERETT HAROLD. U. S. Geological Survey, 411 Temple Court Bldg., Atlanta, Ga	Oct. 1, 1907
TALLMAN, PAUL BERTRAM. Representing Warren & Wetmore, Archts., New Terminal Station; Address, Crawford and Texas Ave., Houston, Tex	Oct. 3, 1905
TAPPAN, ROGER. Care, Baring Bros. & Co., Ltd., 8 Bishopsgate St., Within, London, E. C., England	Dec. 3, 1884
TATUM, ROBERT LEE. U. S. Junior Engr., Box 404, Vicksburg, Miss.	Nov. 8, 1909
TAYLOR, WARREN CROSBY. Care, Trussed Concrete Steel Co., Detroit, Mich	Feb. 4, 1908
TEAL, JONATHAN ERNEST. Asst. Engr., Mo. Pac. Ry. Co., St. Louis, Mo	June 1, 1909
TEFFT, WILLIAM WOLCOTT. 724 W. Washington St., Jackson, Mich.	Mar. 31, 1908
TEICHERT, ADOLPH, JR. 2401 J St., Sacramento, Cal	July 1, 1909
TERRY, ARTHUR LINVILLE, JR. Filtration Engr. (Hungerford & Terry), 1414 Penna. Bldg., Philadelphia, Pa	Mar. 5, 1907
THOMPSON, GORDON SAXTON. Asst. in Dept. of Mechanics, Rens. Poly. Inst., 689 Second Ave., Troy, N. Y	Sept. 5, 1905
THOMSON, FRED MORTON. Lockhart, Tex	Oct. 6, 1908
THOMSON, WARREN BROWN. Care, Engr. of Bridges, B. & A. R. R., Room 365, South Terminal, Boston, Mass	Feb. 5, 1907
TIFFANY, NATHAN NEWTON. Civ. Engr. and Surv.; Mgr., East Hampton Elec. Light Co., East Hampton, N. Y	June 5, 1906
TILLIT, PEDRO ERNESTO. P. O. Box 1207, Lima, Peru	Oct. 6, 1908
TILLSON, EDWIN DELEVAN. 179 Marcy Ave., Brooklyn, N. Y	Mar. 2, 1909
TINKHAM, RALPH RUSSELL. Supt., 11th Dist., U. S. L. H. Est., 212 Old Federal Bldg., Detroit, Mich	Oct. 3, 1905
TIRRELL, CHARLES EDWARDS. Care, A. Friedrich & Sons Co., 106 Mill St., Rochester, N. Y	Sept. 4, 1906
TODD, OLIVER JULIAN. Field Asst. to City Engr. of San Francisco; Address, Tuolumne, Tuolumne Co., Cal	Aug. 31, 1909
TOENSFELDT, HANS CARL THOMAS. Structural Engr., Board of Education, 410 Board of Education Bldg. (Res., 4670 Gibbons St.), St. Louis, Mo	April 1, 1902
TOLL, ASAHEL CLARK. 332 Everett Ave., Palo Alto, Cal	Mar. 5, 1907
TOLL, ROGER WOLCOTT. Eng. Dept., Denver City Tramway Co. (Res., 215 E. 11th Ave.), Denver, Colo	Oct. 5, 1909

	Date of Membership.
Towle, Foster. Asst. Engr., U. S. Reclamation Service, Fort Shaw, Mont	Oct. 30, 1906
Tozzer, Arthur Clarence. Supt. of Constr., Turner Constr. Co., 11 Broadway, New York City	April 4, 1905
Treadwell, William Adams. Bridge Draftsman, State Dept. of Highways, Albany, N. Y	April 4, 1905
Trowbridge, Alfred Lockwood. Care, Pacific Gas & Elec. Co., 445 Sutter St., San Francisco, Cal	Sept. 3, 1907
True, Albert Otis. Care, Hering & Fuller, 170 Broadway, New York City	Feb. 5, 1907
Turner, Charles Russell. 456 Salem St., Malden, Mass	Oct. 3, 1905
Turner, Le Baron. Engr., U. S. Wind Engine & Pump Co., Batavia, Ill	Sept. 5, 1905
Tutherly, George Cotton. 615 Sunset Ave., Asbury Park, N. J.	April 30, 1907
Tyler, Richard Gaines. 195 Cypress St., Newton Center, Mass.	Oct. 6, 1908
Tyler, William Rogers. Branch Office Mgr. and Engr., Care Brinley & Holbrook, Engrs., 21 South St., Morristown, N. J	Feb. 2, 1909
Vandervoort, Benjamin Franklin. Asst. Engr., Public Service Comm., 1st Dist., 899 Eagle Ave., New York City	Mar. 2, 1909
Van Horne, John Russell. 165 Broadway, Room 2611, New York City	Nov. 5, 1907
Van Vleck, James Brackett. 910 Ave. P, Brooklyn, N. Y	May 5, 1908
Van Zile, Harry Lee. Pres., Franklin Boiler Works Co., 39 Cortlandt St., New York City	Jan. 6, 1886
Veatch, Nathan Thomas, Jr. Res. Engr. for The J. S. Worley Co., Cons. Engrs., 206 Reliance Bldg., Kansas City, Mo	Nov. 8, 1909
Vensano, Harry Chittenden. Civ. Engr. with Pac. Gas & Elec. Co., 445 Sutter St., San Francisco, Cal	June 4, 1907
Villa, Miguel. Asst. Engr. of the Dept. of Rivers and Harbors, Public Works Arsenal, Havana, Cuba	Oct. 6, 1908
Vogel, John Leonard. 61 Belmont Ave., Jersey City, N. J	Nov. 5, 1907
Volck, Adalbert George. Asst. to Supt. of Constr., N. Y. C. & H. R. R. R. Co., 437 Spencer Pl., Mott Haven, New York City	Dec. 1, 1908
von Blücher, Carl Felix Kill-Mar. Civ. Engr. and Surv. (C. F. H. v. Blücher & Sons), Corpus Christi, Tex	Oct. 30, 1906
von Geldern, Edward. Asst. Engr. of Levee Dist. No. 1, Yuba City, Sutter Co., Cal	May 5, 1908
Wachtel, Louis. Leveler, State Highway Comm., Gloversville, N. Y	Mar. 2, 1909
Waddell, Needham Everett. McClintic-Marshall Constr. Co., Rankin, Pa	Sept. 1, 1908

	Date of Membership.
WAITE, DONALD CRAMER. Asst. Engr., Interborough Rapid Transit Co., 165 Broadway (Res., 615 West 144th St.), New York City	Jan. 3, 1905
WALKER, CHARLES LEOPOLD. Asst. Prof. in Civ. Eng., Cornell Univ., 108 Brandon Pl., Ithaca, N. Y	April 6, 1909
WALKER, EDWARD GEORGE. 37 Albany St., Hull, England	April 2, 1907
WALKER, GEORGE JOHNSON. Draftsman with Heyl & Patterson, Contr. Engrs. (Res., 731 S. Negley Ave.), Pittsburg, Pa.	Dec. 6, 1904
WALTON, HARRY COLLINS. Designer, McClintic-Marshall Constr. Co., 21 Park Row, New York City	Jan. 5, 1909
WARD, EDWARD ASHTON. 1197 Broad St., Newark, N. J	Oct. 5, 1909
WARD, GEORGE MERRITT. Gen. Mgr. of Constr., Suburban Constr. Co., 111 Broadway, New York City	Nov. 5, 1907
WARLOW, ADONIRAM JUDSON. Bethlehem Steel Co., 313 W. North St., Bethlehem, Pa	May 1, 1906
WARNER, JAMES MADISON. Res. Engr., Pecos & Northern Texas Ry., Ovalo, Tex	April 6, 1909
WATKINS, SAMUEL DALE. 307 Roxborough Ave., Roxborough, Philadelphia, Pa	Mar. 31, 1908
WATSON, GEORGE LINTON. Chf. Engr., United Paving Co., 535 Bartlett Bldg., Atlantic City, N. J	Mar. 6, 1906
WEAVER, EARLL CHASE. Asst. Engr., Hegardt & Clarke, Board of Trade Bldg., Portland, Ore	Mar. 31, 1908
WEBSTER, ROYAL SYLVESTER. First Asst. Engr., Havana Central R. R. Co., Zulueta 85, Havana, Cuba	Oct. 6, 1903
WEIDNER, CARL ROBERT. Instr. in Hydr. Eng., Univ. of Wisconsin, 18 W. Gilman St., Madison, Wis	Feb. 28, 1905
WELLER, WILLIAM EARL. Deputy City Engr., 63 Robinson St., Schenectady, N. Y	Jan. 7, 1908
WENTWORTH, GEORGE LANSING. 123 West 44th St., New York City	April 6, 1909
WESTON, FREDERICK SAMPSON. Middleboro, Mass	Oct. 5, 1909
WESTOVER, HENRY CHRISTOPHER. (Archer, Rollins & Co.), 534 Beals Bldg., Kansas City, Mo	Nov. 1, 1904
WHITAKER, WILLIAM FRANKLIN. Supt. of Canals, Kern County Canal & Water Co., 2106 B St., Bakersfield, Cal	April 4, 1905
WHITBECK, LEE FIELD. Ingro. Residente, Ferrocarril Interoceanico de Mexico, Otumba, Mexico	Dec. 6, 1904
WHITSIT, LYLE ANTRIM. Prin. Asst. Engr., Long Sault Development Co. and St. Lawrence River Power Co., Massena, N. Y	Oct. 31, 1905
WILBANKS, JOHN ROBERT. Care, Madeira-Mamoré Ry., Manãos, Brazil	June 4, 1907
WILCOX, CLARK LUZERNE. Treas., The Pitt Constr. Co., Inc., 821 Fulton Bldg., Pittsburg, Pa	Dec. 3, 1901

		Date of Membership.
	Wilder, Alvin Dumond. N. W. Cor., Dwight Way and Prospect, Berkeley, Cal	Oct. 6, 1908
C.	Wiley, Hugh Lemuel. Garberville, Cal	April 2, 1907
	Wiley, Ralph Benjamin. Instr. in Hydr. and San. Eng., Purdue Univ., Lafayette, Ind	Feb. 4, 1908
	Willard, William Clyde. Prof. of Railway and Highway Eng., Washington State Coll., Pullman, Wash	Feb. 4, 1908
	Willcomb, George Edward. Chemist in Chg., Albany Filtration Works, 113 North Allen St., Albany, N. Y	Oct. 30, 1906
	Williams, Clement Clarence. Acting Prof. of Civ. Eng., Univ. of Colorado, 1133 Pleasant St., Boulder, Colo	June 1, 1909
	Williams, Harold S. Caldwell, Idaho	Sept. 1, 1908
	Williams, LeRoy Duncan. County Surv., Macon Co., Macon, Mo	Feb. 5, 1907
	Williams, Rector Linde. Structural Engr., Mauran, Russell & Garden, Chemical Bldg., St. Louis, Mo	Sept 1, 1908
	Willis, Albert Jones. Instr. in Civ. Eng., Armour Inst. of Tech. (Res., 3548 Forest Ave.), Chicago, Ill	June 4, 1907
	Wilmot, James. Office of Public Roads, Washington, D. C	Sept. 1, 1908
	Wilmot, Sydney. Care, Office of Public Roads, Washington, D. C	Nov. 8, 1909
	Wilson, Samuel. 4120 Kingman Blvd., Des Moines, Iowa	April 3, 1906
	Wilson, William West. 203 Washington Park, Brooklyn, N. Y	Dec. 4, 1906
	Winans, Lawrence Lewis. Fruitville, Howell Co., Mo	Nov. 8, 1909
	Winchester, Thomas Harrison. 66 Arlington Pl., Macon, Ga.	May 4, 1909
	Wintermute, Ferd Clark. Civ. and Min. Engr. (Young & Wintermute), 410 Second National Bank, Wilkes-Barre, Pa	July 1, 1909
	Wise, Russell Sherwood. 34 Bloomfield Ave., Passaic, N. J.	April 2, 1907
	Wittstein, Herman Lewis. Insp., Board of Water Supply, City of New York, High Falls, N. Y	Oct. 6, 1908
	Wolkowyski, Alexander Ilich. Suwalki, Russia	Jan. 7, 1908
	Wormser, Moritz. Secy. and Treas., The Wormser-Goodman Constr. Co., 2 Rector St., New York City (Res., 90 Porter Pl., Montclair, N. J.)	Feb. 6, 1906
	Wright, Albert Eugene. Asst. Engr., California Development Co., Calexico, Cal	Mar. 3, 1908
	Wright, George Creighton. 35 Grand Ave., Rochester, N. Y.	April 3, 1906
	Wright, Rene Barber. Civ. and Structural Engr., Am. Bridge Co., 669 Wrightwood Ave., Chicago, Ill	Aug. 31, 1909
	Wright, Thomas Judson, Jr. Office of Chf. Engr., Winston-Salem South Bound Ry. Co., Winston-Salem, N. C.	June 1, 1909
	Wright, Thomas Temple. U. S. Junior Civ. Engr., Box 404, Vicksburg, Miss	Sept. 1, 1908

	Date of Membership.
Vyckoff, Charles Rapelyea, Jr. Asst. Engr., Board of Water Supply, City of New York, Realty Bldg., White Plains (Res., 185 Penn St., Brooklyn), N. Y.	May 5, 1903
Vygant, Robert Cecil. Newport, Ore.	Oct. 6, 1908
Eo, William Albert. 130 Bulls Ferry Rd., Weehawken Heights, N. J.	Oct. 1, 1907
Abriskie, Aaron J. 23 Fifth Ave., New York City	July 1, 1885

Juniors, 690.

FELLOWS.

[F. Am. Soc. C. E.]

	Date of Membership
ADAMS, EDWARD DEAN. Banker; Chairman, Executive Comm., Allis-Chalmers Co.; Chairman, Board of Directors, Empire Eng. Corp.; Pres., Bullock Elec. Mfg. Co., 71 Broadway, New York City	Mar. 31, 1891
ALBRIGHT, JOHN JOSEPH. Buffalo, N. Y	April 20, 1886
BELKNAP, WILLIAM RICHARDSON. 2d and Washington Sts., Louisville, Ky	May 28, 1872
BLATCHFORD, ELIPHALET W. 333 North Euclid Ave., Oak Park, Ill	Feb. 6, 1873
CHANUTE, OCTAVE. (*Past-President*). Cons. Engr., 1138 Dearborn Ave., Chicago, Ill. M. F.	Feb. 19, 1868 July 11, 1872
CLARK, EDWARD WHITE. 321 Chestnut St., Philadelphia, Pa	April 8, 1870
COIT, EDWARD WOOLSEY. Address unknown	Sept. 20, 1872
DARWIN, HARRY GILBERT. Vice-Pres. and Gen. Mgr., Waha-Lewiston Land & Water Co., Lewiston, Idaho	Mar. 22, 1887
DU PONT, BIDERMAN. 808 Broome St., Wilmington, Del	Sept. 5, 1873
EVEREST, CHARLES MARVIN. First Vice-Pres., Vacuum Oil Co., 506 West Ave., Rochester, N. Y	Nov. 1, 1892
FARREN, B. N. 1807 Spring Garden St., Philadelphia, Pa	Mar. 12, 1870
FLINT, CHARLES R. Flint & Co., 25 Broad St. (Res., 4 East 36th St.), New York City	June 7, 1876
GREEN, SAMUEL MAGEE. 1235 Wells Bldg., Milwaukee, Wis	Sept. 5, 1888
HILL, JAMES JEROME. Pres., G. N. Ry. Co., St. Paul, Minn	Jan. 10, 1889
HOLMAN, STEPHEN. 150 Atlantic Ave., Swampscott, Mass	June 29, 1872
KIDDLE, ALFRED WATTS. 115 Broadway, New York City	Oct. 3, 1893

Date of Membership.

Merritt, George. Address unknown........................ May 6, 1870

Meyer, Henry Coddington. 1 Madison Ave., New York City.. Oct. 22, 1885

Richmond, Henry A. Cor. Delaware Ave. and Tupper St., Buffalo, N. Y.................................... July 7, 1870

Stanton, John Robert. 11 William St., New York City..... April 4, 1899

Watson, James. Hopatcong House, Landing, N. J.......... Dec. 5, 1872

Welton, Nelson James. Waterbury, Conn................. Jan. 20, 1873

Fellows (not Members), 21.

SUMMARY OF MEMBERSHIP, FEBRUARY 10th, 1910.

Honorary Members	8
Corresponding Members	2
Members	2 582
Associate Members	1 845
Associates	166
Juniors	690
Fellows (not Members)	21
Total	5 314

GEOGRAPHICAL LIST.

NORTH AMERICA.

CANADA. Total Membership, 100.

Members.—***Almonte, Ont.***—A. Bell. ***Amherstburg, Ont.***—C. Y. Dixon. ***Barrie, Ont.***—F. Moberly. ***Brandon, Man.***—R. E. Speakman. ***Calgary, Alta.***—G. A. McCarthy. ***Campbellford, Ont.***—H. P. Bell. ***Dawson, Y. T.***—C. A. Thomas. ***Edmonton, Alta.***—J. Callaghan. ***Glace Bay, N. S.***—G. H. Duggan. ***Hamilton, Ont.***—J. Hobson, R. M. Roy. ***Hampton, N. B.***—E. G. Evans. ***Keremeos, B. C.***—J. H. Kennedy. ***Matheson, Ont.***—A. T. Tomlinson. ***Medicine Hat, Alta.***—A. Grace. ***Moncton, N. B.***—P. S. Archibald, J. M. Floesch. ***Montreal, Que.***—W. I. Bishop, A. C. Dennis, W. J. Francis, A. S. Going, H. Holgate, H. S. Holt, J. A. Jamieson, P. Johnson, H. G. Kelley, J. Kennedy, R. B. Kenrick, R. S. Lea, H. M. MacKay, W. McNab, J. Mayer, P. A. Peterson, A. W. Robinson, J. Ross, J. M. Shanly, F. P. Shearwood, V. K. Spicer, J. G. Sullivan, W. F. Tye. ***North Bay, Ont.***—F. P. Gutelius. ***Ottawa, Ont.***—S. J. Chapleau, C. R. F. Coutlee, S. Fleming, C. H. Keefer, T. C. Keefer, J. L. P. O'Hanly. ***Prince Rupert, B. C.***—J. H. Bacon. ***Sault Ste. Marie, Ont.***—L. H. Davis. ***Sherbrooke, Que.***—E. H. Drury. ***Sydney, N. S.***—M. J. Butler. ***Toronto, Ont.***—W. H. Breithaupt, W. Chipman, F. S. Darling, C. E. Goad, E. H. Keating, C. H. Mitchell, C. H. Rust, C. B. Smith. ***Vancouver, B. C.***—R. F. Hayward. ***Vernon, B. C.***—F. R. Johnson. ***Victoria, B. C.***—F. C. Gamble, E. Mohun. ***Walkerville, Ont.***—W. Pope. ***Winnipeg, Man.***—E. E. Brydone-Jack, W. A. James, H. N. Ruttan, J. E. Schwitzer.

Associate Members.—***Amherstburg, Ont.***—H. Hodgman. ***Montreal, Que.***—M. E. Brooks, C. B. Brown, Jr., C. E. Gudewill, R. E. Hunter, C. M. Morssen. ***Niagara Falls, Ont.***—K. F. Cooper. ***Outlook, Sask.***—B. Ripley. ***Prince Rupert, B. C.***—W. H. Ferguson. ***Red Deer, Alta.***—J. G. MacGregor. ***St. Boniface, Man.***—McC. P. Blair. ***Saint John, N. B.***—J. K. Scammell. ***Shawinigan Falls, Que.***—P. H. Falter. ***Toronto, Ont.***—H. C. Baker, Jr., F. F. Longley, C. W. Noble, W. F. Scott. ***Vancouver, B. C.***—C. P. Moss, J. V. Nimmo. ***Winnipeg, Man.***—T. J. S. Edelen, J. D. Matheson.

Associates.—***Montreal, Que.***—A. Chaussé, T. J. Drummond. ***Walkerville, Ont.***—G. G. Stroebe.

Juniors.—***Dawson, Y. T.***—J. S. Hess. ***Fort William, Ont.***—H. S. Hancock, Jr. ***Halifax, N. S.***—C. D. Howe. ***London, Ont.***—K. M. Cameron.

Montreal, Que.—W. C. Brown. ***Toronto, Ont.***—E. W. Hyde, Jr. ***Vancouver, B. C.***—M. C. Burr, M. P. Cotton.

MEXICO. Total Membership, 67.

Members.—***Cananea.***—L. D. Ricketts. ***Ciudad Juárez.***—M. M. Mendiola. ***Colima.***—A. P. Herbert, R. H. Vose. ***Culiacan.***—F. E. Butterfield. ***Escalon.***—V. P. Safford. ***Ganahl.***—A. F. Wrotnowski. ***Guanajuato.***—W. H. Puffer. ***Jalapa.***—H. S. Kerr. ***Manzanillo.***—E. K. Smoot. ***Mexico.***—R. Adam, F. Adams, M. M. Barragan, F. W. Blackford, J. B. Body, R. E. Briggs, S. Contri, S. J. Fortin, R. Gayol, A. L. Jones, L. Kingman, M. Marroquin y Rivera, J. W. Miles, A. L. Mills, A. Peimbert, G. Beltram y Puga, A. B. Ross, H. McG. Taylor. ***Monterey.***—G. R. G. Conway, J. E. Garrett, R. Meyer, N. Turner. ***Orizaba.***—S. W. Stacpoole. ***Rincon Antonio.***—A. M. C. Byers. ***Salina Cruz.***—J. Shand. ***San Blas.***—E. A. H. Tays. ***Santa Fé.***—I. Mathewson. ***Sombrerete.***—H. L. Heldt. ***Tlahualilo.***—H. W. Potter. ***Vera Cruz.***—D. Coe. ***Villaseñor.***—T. K. Mathewson.

Associate Members.—***Apulco.***—J. D. Lombardo. ***Cananea.***—V. R. Walling. ***Churubusco.***—W. A. Hill. ***Colombres.***—F. W. Andros. ***Coneto.***—C. F. Parker. ***Cuatotolápam.***—J. C. Hitchman. ***Durango.***—C. J. Carroll. ***Esperanza.***—R. R. McGregor. ***Gamboa.***—D. D. Colvin. ***Hostotipaquillo.***—J. B. Wilson. ***Madera.***—T. W. R. Teigen. ***Mexico.***—V. LeR. Havens, E. Ortiz, A. Y. Sundstrom, E. B. L. Unger, S. L. Wonson. ***Monterey.***—F. H. Dillon, W. O. Galbreath. ***Nueva Casas Grandes.***—W. Charnley. ***Torreón.***—W. F. Lineberger. ***Vera Cruz.***—C. P. Webber.

Associates.—***Durango.***—W. W. Graham.

Juniors.—***Atlixco.***—G. B. G. Hull. ***Cumuripa.***—W. M. Sanger. ***Monterey.***—V. Saucedo. ***Otumba.***—L. F. Whitbeck.

UNITED STATES.

ALABAMA. Total Membership, 28.

Members.—***Birmingham.***—T. H. Aldrich, W. B. Allen, J. R. Carter, J. W. Kendrick, S. Lea, Jr., J. A. Montgomery, A. C. Olney, H. F. Wilson, Jr. ***Decatur.***—W. A. McCalla. ***Gantts Quarry.***—J. S. Sewell. ***Leeds.***—F. H. Lewis. ***Mobile.***—H. Jervey, N. A. Yuille. ***Montgomery.***—D. N. Andrews. ***Tuscaloosa.***—C. M. Ayres.

Associate Members.—***Ashville.***—A. M. Turner. ***Auburn.***—G. N. Mitchem. ***Birmingham.***—F. Furlow, J. R. Pill. ***Kingman.***—W. S. Winn. ***Leeds.***—C. J. Eld, Jr. ***Mobile.***—J. M. Pratt. ***Pennington.***—W. Heer, Jr. ***Riverton.***—C. E. Bright. ***Tuscaloosa.***—G. K. Little.

Juniors.—***Auburn.***—M. S. Harvey. ***Birmingham.***—M. M. Farley. ***Mobile.***—F. F. Pillet.

GEOGRAPHICAL DISTRIBUTION

ALASKA. Total Membership, 1.

Members.—***Seward.***—W. B. Ruggles.

ARIZONA. Total Membership, 19.

Members.—***Phœnix.***—L. C. Hill, F. Teichman, E. D. Vincent. ***Prescott.***—W. A. Drake. ***Tucson.***—A. B. Paine. ***Yuma.***—J. D. Fauntleroy, F. L. Sellew.

Associate Members.—***Globe.***—J. S. Barlow. ***Kelvin.***—E. Stenger. ***Phœnix.***—S. K. Baker, O. A. Turney. ***Roosevelt.***—C. W. Smith. ***Tucson.***—J. C. McClure, G. E. P. Smith. ***Yuma.***—L. M. Lawson.

Associates.—***Tucson.***—L. A. Waterbury.

Juniors.—***Phœnix.***—F. L. Humphrey, R. R. Ryan. ***Tucson.***—G. H. Myers.

ARKANSAS. Total Membership, 12.

Members.—***Fayetteville.***—E. A. Steece. ***Little Rock.***—P. R. Van Frank, Jr. ***Mansfield.***—G. E. Otis. ***Texarkana.***—H. DeW. Smith.

Associate Members.—***Fayetteville.***—J. J. Knoch. ***Fort Smith.***—C. W. L. Armour. ***Little Rock.***—D. A. MacCrea, W. F. Reichardt, G. A. Watkins. ***Mena.***—C. E. Johnston. ***Rob Roy.***—J. F. Wilhelm.

Associates.—***Stamps.***—F. W. Green.

CALIFORNIA. Total Membership, 302.

Honorary Members.—***Mare Island.***—G. E. Gray. ***San Francisco.***—G. Davidson.

Members.—***Berkeley.***—C. Derleth, Jr., P. E. Harroun, L. J. Hohl, C. G. Hyde, S. E. Kieffer, H. Kower, M. J. Lorraine, E. C. Murphy, F. Soulé. ***Bishop.***—W. H. Leffingwell. ***Calexico.***—H. T. Cory, F. C. Herrmann. ***Del Mar.***—H. C. Boyden. ***Dixon.***—J. Ahern. ***East Oakland.***—H. A. Schulze. ***Fresno.***—I. Teilman. ***Grass Valley.***—A. DeW. Foote. ***Hanford.***—T. Berry. ***Hollywood.***—H. Alber. ***Inglewood.***—G. A. Wetherbee. ***Los Angeles.***—J. F. Barnard, S. G. Bennett, W. A. Brackenridge, W. H. Code, D. W. Cunningham, R. W. Fenn, A. B. Fitch, J. A. Fulton, H. Hamlin, H. Hawgood, F. D. Howell, Jr., W. D. Larrabee, J. B. Lippincott, O. O. McReynolds, W. Mulholland, E. Newman, F. H. Olmsted, O. K. Parker, J. L. Phillips, J. H. Quinton, W. H. Sanders, J. D. Schuyler, A. L. Sonderegger, S. Storrow, F. E. Trask, E. L. Veuve, E. H. Warner, E. T. Wheeler, E. L. Woodruff, E. T. Wright. ***Mare Island.***—F. B. Smith. ***Monrovia.***—L. W. Brown. ***North Fork.***—G. S. Hewins. ***Oakland.***—E. M. Boggs, P. F. Brown, L. J. Le Conte, F. T. Oakley. ***Orland.***—W. W. Schlecht. ***Orloff.***—C. S. Compton. ***Oroville.***—E. Oliver. ***Palo Alto.***—J. Herron, C. B. Wing. ***Pasadena.***—T. D. Allin, W. B. Clapp, B. Moody. ***Pomona.***—A. W. Wright. ***Redlands.***—W. A. Nichols. ***Riverside.***—J. R. Elliott, H. E. Green, H. E. Warrington. ***Sacramento.***—N. Ellery, P. M. Norboe, G. N. Randle,

C. W. Raymond. ***San Diego.***—A. B. Fletcher. ***San Francisco.***—A. L. Adams, F. J. Amweg, L. E. Ashbaugh, S. Baker, J. Q. Barlow, J. Biddle, A. M. Bienenfeld, B. Bienenfeld, V. G. Bogue, Le G. Brown, W. A. Cattell, M. C. Couchot, G. L. Dillman, W. A. Doble, J. H. Dockweiler, R. G. Doerfling, E. Duryea, Jr., W. R. Eckart, W. C. Edes, G. R. Field, C. S. Freeland, J. D. Galloway, H. D. Gates, E. F. Haas, W. H. Hall, W. C. Hammatt, W. H. Heuer, S. G. Hindes, H. C. Holmes, H. Homberger, W. Hood, A. M. Hunt, T. H. Jackson, N. B. Kellogg, B. P. Legaré, J. B. Leonard, C. List, C. H. McKinstry, M. Manson, W. Meredith, E. J. Molera, F. R. Muhs, M. M. O'Shaughnessy, F. J. H. Rickon, F. Riffle, E. A. Rix, E. J. Schneider, C. H. Snyder, M. L. Tower, C. Uhlig, R. W. Van Norden, O. von Geldern, H. H. Wadsworth, L. Wagoner, J. H. Wallace, J. H. G. Wolf. ***San José.***—J. G. McMillan. ***San Pedro.***—D. E. Hughes. ***San Rafael.***—D. E. Melliss. ***Santa Barbara.***—J. F. Flagg. ***Santa Clara.***—C. E. Moore. ***Santa Monica.***—F. Eaton. ***Stanford University.***—J. C. L. Fish, C. D. Marx. ***Stone Canon.***—H. McKay. ***Surrey.***—De W. L. Reaburn. ***Tiburon.***—F. T. Chambers. ***Ventura.***—G. C. Power. ***Willows.***—D. W. Ross. ***Yuba City.***—G. McMurtry.

Associate Members.—***Alleghany.***—C. W. McMeekin. ***Berkeley.***—G. H. Baldwin, C. P. Bowie, W. V. Clark, B. A. Etcheverry, A. V. Saph, T. B. Sears, E. L. Soulé, F. H. Tibbetts. ***Bishop.***—A. McC. Strong. ***Davenport.***—F. Davis. ***Exeter.***—J. H. Crosett. ***Grass Valley.***—A. B. Foote. ***Larkin.***—T. G. Janney. ***Los Angeles.***—J. C. Avakian, W. K. Barnard, J. C. Clausen, H. W. Dennis, J. P. Gardiner, J. B. Harris, C. W. Lawrence, J. W. Martin, C. R. Olberg, J. H. Payne, H. C. Phillips, W. S. Post, W. C. Sawyer, W. M. Thomas, W. R. Wheaton, A. B. White, N. D. Whitman, S. W. Williams, W. Woodard. ***Monterey.***—T. B. Hunter. ***North Fork.***—H. M. Daugherty. ***Oakland.***—C. E. Beugler, W. S. Farley, W. N. Frickstad. ***Ocean Park.***—H. D. Chapman. ***Orland.***—F. H. Tillinghast. ***Pasadena.***—S. J. Van Ornum, F. E. Wilcox. ***Potter Valley.***—N. A. Eckart. ***Purser.***—E. N. Prouty. ***Quincy.***—F. M. Robinson. ***Sacramento.***—G. R. Davis, G. B. Lorenz, C. Maughmer. ***San Diego.***—B. B. Boyd, T. B. Downer, W. J. Gough. ***San Francisco.***—G. W. Armitage, D. Ash, M. J. Bartell, F. G. Baum, G. A. Bos, J. O. Burrage, P. L. Bush, H. A. Campbell, E. M. Chadbourne, R. S. Chew, H. De H. Connick, M. R. Daniels, R. M. Drake, C. E. Gilman, H. L. Haehl, C. R. Hall, G. S. Hill, L. E. Hunt, L. R. Jorgensen, S. A. Jubb, A. Judell, N. B. Livermore, C. J. McGonigle, A. H. Markwart, O. C. Merrill, J. M. Owens, W. H. Popert, E. T. Thurston, Jr., F. G. White, J. H. Wise, C. N. Young. ***San José.***—A. Swickard. ***San Luis Obispo.***—G. W. Corrigan. ***San Mateo.***—T. J. Jones. ***Santa Paula.***—A. C. Hardison. ***Vallejo.***—A. B. Dodd, F. E. Frey. ***Visalia.***—C. H. Holley, H. H. Holley. ***Willows.***—W. G. Davies, L. L. Gay.

Associates.—***Palo Alto.***—G. M. Herron. ***San Francisco.***—S. K. Colby. ***Visalia.***—J. C. Hays.

Juniors.—***Bakersfield.***—A. T. Parsons, W. F. Whitaker. ***Benicia.***—A. K. Macfarlane. ***Berkeley.***—W. E. Burns, E. L. Cope, C. L. Dimmler, H. B. Foster, H. M. Goodman, H. F. Gray, T. K. Sweesy, A. D. Wilder. ***Bowman.***—E. L. Marsh. ***Calexico.***—A. E. Wright. ***East Auburn.***—L. L. Hohl. ***Fresno.***—L. L. Carter. ***Garberville.***—H. L. Wiley. ***Independence.***—C. H. Lee. ***Los Angeles.***—W. F. Bixby, F. Gillelen, C. T. Leeds, R. J. Reed. ***Modesto.***—A. Griffin. ***Monterey.***—E. G. Brua, T. F. Rogers. ***Oakland.***—F. W. Haselwood. ***Palo Alto.***—R. A. Beebee, J. H. Foss, F. H. Fowler, R. B. Moran, G. S. Strout, A. C. Toll. ***Piedmont.***—A. Kempkey, Jr. ***Sacramento.***—J. W. Horton, A. Teichert, Jr. ***San Diego.***—A. W. Earl. ***San Francisco.***—F. Babcock, H. N. Bishop, H. R. Burroughs, J. R. Cahill, W. P. Day, J. J. Ferrier, N. M. Halcombe, E. H. Hatch, W. L. Huber, E. F. Kriegsman, M. Nikolitch, K. E. Parker, O. P. Shelley, A. L. Trowbridge, H. C. Vensano. ***San José.***—E. O. Billwiller, H. H. Hall, F. A. Nikirk. ***Saratoga.***—A. A. M. Russell. ***Smartsville.***—J. W. Gross. ***South Berkeley.***—G. W. Howson, Jr. ***Tracy.***—A. J. McNeil. ***Tuolumne.***—O. J. Todd. ***Vallejo.***—T. D. Kilkenny. ***Yuba City.***—E. von Geldern.

COLORADO. Total Membership, 70.

Members.—***Blanca.***—L. D. Blauvelt. ***Canon City.***—A. R. Livingston. ***Denver.***—G. G. Anderson, J. A. Beeler, G. M. Bull, H. J. Burt, C. W. Comstock, H. W. Cowan, H. S. Crocker, J. W. Emig, J. E. Field, G. N. Houston, J. B. Hunter, T. W. Jaycox, M. S. Ketchum, G. H. Matthes, H. F. Meryweather, W. Pearl, G. T. Prince, H. A. Sumner, R. S. Sumner, D. G. Thomas, J. C. Ulrich, C. D. Vail, E. F. Vincent, R. F. Walter, W. C. Wetherill, T. L. Wilkinson. ***Glenwood Springs.***—T. Rosenberg. ***Greeley.***—O. F. Shattuck. ***La Junta.***—F. M. Bisbee. ***Littleton.***—J. E. Maloney. ***Mack.***—M. W. Cooley. ***Paonia.***—W. B. Rittenhouse. ***Salida.***—J. W. Deen.

Associate Members.—***Boulder.***—R. T. Robinson. ***Canon City.***—C. A. Wentworth. ***Conejos.***—C. B. Sampson. ***Denver.***—A. G. Allan, F. C. Carstarphen, L. B. Curtis, T. G. Elbury, E. C. Jansen, V. A. Kauffman, E. A. Lee, C. W. Raynor, J. A. Sargent, F. G. Skinner, A. Spengler, M. E. Witham. ***Greeley.***—R. D. Tyler, J. R. Wortham. ***Holly.***—S. G. Porter. ***Montrose.***—J. H. Miner. ***Palisades.***—E. Montgomery. ***Pueblo.***—A. A. Weiland. ***San Luis.***—W. DeW. Waltman. ***Trinidad.***—W. R. Lewis.

Associates.—***Denver.***—L. C. Phipps.

Juniors.—***Boulder.***—C. C. Williams. ***Canon City.***—H. G. Raschbacher. ***Colorado Springs.***—H. A. Appel. ***Cripple Creek.***—A. L. B. Moser. ***Denver.***—L. E. Bishop, L. R. Hinman, R. W. Toll. ***Grand Junction.***—S. O. Harper. ***Montrose.***—J. H. Fertig. ***Penrose.***—W. Holbrook. ***Telluride.***—T. Lindsley.

CONNECTICUT. Total Membership, 75.

Members.—***Berlin.***—D. E. Bradley, C. F. Chase. ***Bridgeport.***—T. B. Ford. ***Derby.***—D. S. Brinsmade. ***East Berlin.***—O. Benson. ***Hartford.***—G. M. Bond, H. R. Buck, R. N. Clark, F. L. Ford, J. T. Henderson, T. H. McKenzie, H. Souther. ***New Britain.***—C. M. Jarvis. ***New Haven.***—C. Blakeslee, A. J. Du Bois, W. R. Dunham, Jr., F. J. Easterbrook, C. C. Elwell, C. A. Ferry, H. H. Gladding, C. R. Harte, A. B. Hill, C. W. Kelly, E. W. Lewis, E. H. McHenry, E. E. Minor, W. H. Moore, C. H. Nichols, J. A. Norcross, H. L. Ripley, T. C. B. Snell, G. E. Verrill. ***New London.***—F. W. LaForge, H. Taylor. ***Noroton.***—A. H. Renshaw. ***Norwalk.***—R. Van Buren. ***Norwich.***—C. H. Preston. ***Saybrook.***—E. W. Bush. ***Waterbury.***—R. A. Cairns. ***West Haven.***—E. Gagel.

Associate Members.—***Berlin.***—R. C. Noerr. ***Bridgeport.***—S. P. Senior. ***Bristol.***—R. DeW. Havens. ***Derby.***—D. E. Brinsmade. ***East Berlin.***—D. W. Bliem. ***Hartford.***—W. J. Backes, A. H. Greenwood, P. Sheldon, E. W. Wiggin. ***Meriden.***—C. L. Cole. ***Milford.***—R. F. Stoddard. ***New Haven.***—A. H. Terry. ***Norwich.***—L. M. Young. ***Rockfall.***—H. Miller. ***Stamford.***—H. A. Parsons. ***Thomaston.***—C. W. Eddy. ***Waterbury.***—C. H. Preston, Jr., W. T. Spencer. ***West Hartford.***—A. B. Alderson, W. E. Johnson. ***West Haven.***—G. R. Johnson.

Associates.—***Litchfield.***—D. G. Ambler. ***New Haven.***—H. McBurney. ***Stamford.***—G. A. Weber. ***Waterbury.***—M. A. O. Stilson.

Juniors.—***Bridgeport.***—H. F. Porter, H. A. Seeley. ***East Hartford.***—A. S. Brainard. ***Hartford.***—W. S. Brewer. ***New Britain.***—A. W. Bacon. ***New Haven.***—E. W. Crawley. ***New London.***—E. L. Chandler. ***Stamford.***—R. G. Rice. ***Thomaston.***—H. G. Payrow.

Fellows.—***Waterbury.***—N. J. Welton.

DELAWARE. Total Membership, 16.

Members.—***Bethany Beach.***—W. R. Browne. ***Delaware City.***—F. C. Warner. ***Edge Moor.***—E. Mowlds. ***Newark.***—J. R. Maxwell. ***New Castle.***—A. Bryson. ***Wilmington.***—W. H. Fenn, T. C. Hatton.

Associate Members.—***Wilmington.***—H. W. Hatton, E. R. Mack, H. L. Maier, A. J. Taylor.

Associates.—***Wilmington.***—A. J. Moxham.

Juniors.—***Wilmington.***—W. J. Horrigan, J. A. Kienle, W. G. Rommel.

Fellows.—***Wilmington.***—B. du Pont.

DISTRICT OF COLUMBIA. Total Membership, 101.

Honorary Members.—***Washington.***—A. Mackenzie.

Members.—***Washington.***—F. V. Abbot, F. L. Averill, T. C. J. Baily, Jr., E. C. Barnard, F. C. Boggs, D. S. Carll, S. Cosby, L. M. Cox, W. Crozier, A. C. Cunningham, A. P. Davis, C. E. L. B. Davis, W. F. Dennis, E. M.

Douglas, W. J. Douglas, C. G. Elliott, M. T. Endicott, O. H. Ernst, F. Freyhold, B. R. Green, W. C. Gunnell, P. C. Hains, T. H. Handbury, J. H. Hanna, E. D. Hardy, R. C. Hollyday, D. J. Howell, R. L. Hoxie, J. C. Hoyt, C. B. Hunt, W. V. Judson, D. W. Lum, B. F. Mackall, C. A. McKenney, R. B. Marshall, C. A. Miner, J. J. Morrow, A. T. Mosman, D. W. Murphy, F. H. Newell, G. L. Nicolson, L. W. Page, W. N. Page, R. E. Peary, A. E. Phillips, F. C. Prindle, G. R. Putnam, F. Sutton, S. Tatum, F. Thompson, O. H. Tittmann, A. H. Weber, H. M. Wilson.

Associate Members.—*Washington.*—R. E. Adams, C. Beale, W. D. Connor, F. H. Cooke, W. P. Darwin, H. Davis, L. S. Doten, R. Farnham, Jr., J. B. Gordon, U. S Grant, 3rd, E. C. Heald, N. H. Heck, E. A. Hill, A. B. Ilsley, W. Kelly, E. A. Keys, M. O. Leighton, W. C. Lyon, M. J. McDonough, T. W. Marshall, F. E. Matthes, H. Munroe, C. L. Nelson, T. J. Powell, H. A. Pressey, T. Riggs, Jr., C. L. Sadler, E. E. Seyfert, J. Stewart, H. Stidham, G. E. Stratton, N. B. Sweitzer, W. McG. Wallace, F. R. Weller, R. Whitman.

Associates.—*Washington.*—A. S. Cushman, E. C. Eckel, G. Pinchot.

Juniors.—*Washington.*—G. E. Edgerton, F. C. Hilder, B. E. Jones, G. R. Jones, H. W. Maynard, M. S. Rich, J. G. Steese, J. Wilmot, S. Wilmot.

FLORIDA. Total Membership, 26.

Members.—*Bartow.*—M. A. Waldo. ***Jacksonville.***—J. M. Braxton, A. F. Harley, W. V. Polleys, J. W. Sackett, E. B. Thomson. ***Key West.***—F. O. Maxson. ***Pensacola.***—G. Rommel, Jr. ***St. Augustine.***—L. R. McLain. ***South Jacksonville.***—F. W. Bruce. ***Tampa.***—W. H. Caldwell, B. Thompson.

Associate Members.—*Apalachicola.*—W. A. Hunicke. ***Jacksonville.***—F. C. Phillips. ***Key West.***—H. R. Hortenstine. ***Marathon.***—R. W. Carter, G. R. Smiley, P. L. Wilson. ***Pensacola.***—G. R. Heckle. ***Pierce.***—A. Schneider. ***St. Cloud.***—B. E. White. ***Tampa.***—W. W. Fineren.

Juniors.—*Apalachicola.*—G. E. Dunan. ***Jacksonville.***—H. I. Snyder. ***Key West.***—J. G. Moore. ***Lakeland.***—H. D. Mendenhall.

GEORGIA. Total Membership, 36.

Members.—*Americus.*—G. M. Eldridge. ***Athens.***—J. W. Barnett. ***Atlanta.***—A. Bonnyman, R. M. Clayton, P. A. Dallis, J. N. Hazlehurst, A. Pew. ***Augusta.***—N. Wingfield. ***Columbus.***—B. H. Hardaway. ***Jackson.***—F. C. Shepherd. ***Macon.***—D. B. Dunn. ***Savannah.***—G. M. Gadsden, H. S. Jaudon, J. de B. Kops.

Associate Members.—*Athens.*—C. M. Strahan. ***Atlanta.***—T. P. Branch, A. V. Gude, Jr., W. A. Hansell, E. K. Knight, P. H. Norcross, C. E. Parsons, C. L. Richardson, G. R. Solomon, W. C. Spiker, H. L. Stevens, J. L. Zachry. ***Augusta.***—J. D. Twiggs, Jr. ***Brunswick.***—W. C. S. Lemen. ***Crystal Springs.***—K. Lindsey. ***Fitzgerald.***—C. W. Murray.

Juniors.—***Atlanta.***—H. H. Sims, E. H. Swett. ***Augusta.***—G. M. Jones. ***Macon.***—T. H. Winchester. ***Savannah.***—E. C. Garvin, E. M. Rhett.

HAWAII. Total Membership, 13.

Members.—***Hilo.***—C. H. Kluegel, R. Quinn. ***Honolulu.***—O. B. French, A. C. Lewerenz, J. T. Taylor.

Associate Members.—***Honolulu.***—G. S. Burrell, E. Schmitt, E. A. Southworth, A. C. Wheeler. ***Kahului.***—H. I. Shoemaker.

Juniors.—***Honolulu.***—J. W. Caldwell, H. Lord. ***Kukuihaele.***—J. C. Foss, Jr.

IDAHO. Total Membership, 33.

Members.—***Boise.***—G. L. Swendsen, F. E. Weymouth, A. J. Wiley. ***Caldwell.***—J. T. Burke. ***Grangeville.***—W. H. Hill. ***Lewiston.***—W. P. Wood. ***Pocatello.***—W. R. Armstrong. ***Richfield.***—C. H. Fitch. ***Rupert.***—C. H. Paul. ***Spirit Lake.***—W. C. Smith. ***Twin Falls.***—F. C. Horn.

Associate Members.—***Bliss.***—C. A. Engle. ***Boise.***—G. H. Bliss, C. C. Fisher, A. B. Mayhew, J. L. Savage, C. Spearman. ***Downey.***—S. D. Clinton. ***Moore.***—C. L. Huff. ***Orofino.***—T. J. Klossowski. ***Pocatello.***—J. P. Congdon, H. A. Roberts. ***Richfield.***—I. W. McConnell. ***Rupert.***—P. M. Fogg. ***Twin Falls.***—A. M. Gilbert, C. B. Smith.

Juniors.—***American Falls.***—L. M. Pill. ***Burley.***—L. E. Johnson. ***Caldwell.***—H. S. Williams. ***Pocatello.***—T. G. McCrory. ***Twin Falls.***—W. H. Fisher. ***Wendell.***—R. S. Larimer.

Fellows.—***Lewiston.***—H. G. Darwin.

ILLINOIS. Total Membership, 270.

Members.—***Alton.***—T. Appleton, E. A. Hermann. ***Atkinson.***—H. E. Reeves. ***Batavia.***—W. H. Finley. ***Champaign.***—I. O. Baker. ***Chicago.***—A. Allen, J. W. Alvord, W. E. Angier, W. C. Armstrong, B. J. Arnold, S. G. Artingstall, A. S. Baldwin, C. B. Ball, W. D. Barber, O. Bates, J. B. Berry, C. E. Billin, W. L. Breckinridge, G. H. Bremner, D. J. Brumley, J. Brunner, H. M. Byllesby, W. J. Cahill, W. M. Camp, E. C. Carter, C. H. Cartlidge, W. H. Chadbourn, Jr., O. Chanute, G. B. Christie, T. W. Clayton, J. A. Cole, T. L. Condron, L. E. Cooley, W. L. Cowles, W. W. Curtis, C. R. Dart, F. E. Davidson, F. A. Delano, F. W. Dencer, De C. Dunlap, H. N. Elmer, J. E. Ericson, L. H. Evans, J. M. Ewen, W. B. Ewing, S. M. Felton, C. R. Fickes, H. B. Fleming, R. Forsyth, L. C. Fritch, J. R. Furman, J. L. Fyfe, R. E. Gaut, R. L. Gifford, H. P. Gillette, H. H. Hadsall, J. C. Hallsted, C. A. Hasbrouck, J. N. Hatch, C. D. Hill, J. B. Hittell, E. Holbrook, G. T. Horton, H. E. Horton, C. W. Hotchkiss, L. J. Hotchkiss, W. M. Hughes, R. W. Hunt, J. D. Isaacs, W. B. Jackson, C. L. Keller, J. W. Kendrick, E. N. Lake, E. H. Lawrence, E. N. Layfield, E. H. Lee, F. J. Llewellyn, J. Lowe, C. F. Loweth, W. A. Lydon, W. S. MacHarg, W. W. Marr, E. D. Martin, A. J. Mason, F. O. Melcher, L. J. Mensch, R. Modjeski, J. E. Moore, E. S. Nethercut,

A. W. Newton, L. A. Nichols, W. R. Patterson, J. W. Pearl, E. T. Pe kins, A. E. Phillips, A. V. Powell, I. Randolph, A. F. Reichmann, A. Righter, L. E. Ritter, A. F. Robinson, W. A. Rogers, W. H. Rosencran S. McM. Rowe, A. T. Sabin, H. R. Safford, C. Schroeder, E. K. Scot E. C. Shankland, R. M. Shankland, E. L. Shaw, F. F. Sinks, H. J. Slife D. Sloan, G. W. Smith, R. C. Smith, I. F. Stern, W. B. Storey, Jr., O. Strehlow, C. L. Strobel, W. D. Taylor, C. V. Weston, G. Weston, H. White, D. J. Whittemore, F. R. Williamson, P. Willis, E. B. Wilson, B. Winslow, G. M. Wisner, E. N. Wood, A. W. Woodman, A. Ziesing. ***Eas St. Louis.***—T. N. Jacob, W. A. Thompson. ***Edwardsville.***—C. A. She pard. ***Evanston.***—J. F. Hayford, C. J. Morse. ***Joliet.***—F. C. Arentz, G. W. Vaughn. ***Litchfield.***—A. G. Kleinbeck. ***Marion.***—R. Hengst. ***North Chicago.***—G. A. McKay. ***Peoria.***—D. H. Maury, S. Russell. ***Riverside.***—W. S. Smith. ***Rock Island.***—J. B. Bassett R. Monroe, A. L. Richards. ***Springfield.***—A. N. Johnson. ***Sterling.***— A. O. Rowse, L. L. Wheeler. ***Urbana.***—S. S. Roberts, A. N. Talbot ***Western Springs.***—J. Nichol.

Associate ***Members.—Alton.***—T. C. Moorshead. ***Bloomington.***—J. G. Mel luish. ***Chicago.***—E. E. Adams, F. W. Adgate, J. L. Allen, W. E. Belche J. C. Blaylock, C. F. Brenn, I. C. Brower, R. M. Brown, C. B. Burdick F. R. Coates, O. F. Cole, A. A. Cother, J. W. Cowper, S. Dean, S. T. D La Mater, H. S. Doyle, E. B. Espenshade, E. J. Fucik, W. F. Graves, P. E Green, H. E. Grimm, T. H. Gronwall, G. E. Gustafson, T. L. D. Hadwen E. McK. Hagar, H. R. Harbeck, W. E. Ingram, M. Johnson, F. R. Judd F. B. Knight, J. C. Koch, C. M. Larson, C. M. Leonard, A. S. Lewis, H. J MacNair, J. de N. Macomb, Jr., J. L. McConnell, R. H. McPherson, W. I Martin, W. Meier, F. E. Morrow, J. E. Murphy, L. Pearse, C. W. Peter sen, T. C. Phillips, W. Raster, E. H. Ravenscroft, H. B. Sauerman, W A. D. Short, J. G. Spielman, J. W. Stewart, H. H. Stout, W. E. S Strong, G. E. Tebbetts, W. A. Theodorson, C. Thuringer, E. E. R. Tratman, W. P. Tunstall, S. Van Pelt, G. S. Walter, E. Walther, M. Wassner, F. W. Webster, J. V. Wescott, O. J. West, R. A. Widdicombe, A. Yappen. ***Dixon.***—A. M. Shaw. ***Evanston.***—L. W. Irish, R. J. Middleton. ***Kewanee.***—J. E. Kemp. ***Moline.***—N. A. Melick. ***Peoria.***—J. A. Harman. ***Shelbyville.***—C. E. Chester. ***Springfield.***—H. E. Bilger C. Older. ***Staunton.***—B. Cole. ***Thomson.***—C. Berry. ***Urbana.***—J. P. Brooks, F. O. Dufour, C. W. Malcolm.

Associates.—***Chicago.***—C. M. Foster, T. F. Quilty, G. H. Scribner, Jr., S. M. Turrill, J. H. Warder.

Juniors.—*Batavia.*—Le B. Turner. ***Charleston.***—S. McCrory. ***Chicago.***— W. H. Alderson, B. Borland, R. H. Burke, J. E. Cahill, F. L. Copeland, W. R. Ewing, J. R. Hall, S. T. Henry, L. L. Hunter, C. B. Lewis, J. W. Ludlow, L. C. O'Byrne, G. H. Paine, R. I. Randolph, W. R. Robinson, G. Schobinger, R. G. Shankland, C. S. Stewart, A. J. Willis, R. B. Wright. ***Dixon.***—L. A. Andrus. ***Paris.***—C. H. Stratton. ***Peoria.***—C. Millard. ***Urbana.***—D. A. Abrams.

ellows.—*Oak Park.*—E. W. Blatchford.

INDIANA. Total Membership, 30.

embers.—*Indianapolis.*—C. C. Brown, M. M. Defrees, C. S. Millard, R. P. Woods. ***Michigan City.*—**H. U. Wallace. ***Rushville.*—**J. W. Moore. ***South Bend.*—**F. A. Bryan, A. J. Hammond. ***Terre Haute.*—**M. A. Howe.

ssociate Members.—*Bedford.*—G. A. Haynes. ***Converse.*—**J. L. Dillard. ***Evansville.*—**J. B. Cameron, P. Chipman, F. H. Stephenson. ***Hammond.*—**M. E. Shire. ***Indianapolis.*—**W. G. Atwood, T. R. H. Daniels, A. C. Harrington, A. R. Holliday, E. C. Strathmann. ***Lafayette.*—**H. O. Garman, W. K. Hatt, R. L. Sackett. ***Logansport.*—**H. F. Coleman. ***Terre Haute.*—**J. A. Green.

ssociates.—*Indianapolis.*—H. E. Jordan. ***West Lafayette.*—**A. P. Poorman, A. Smith.

uniors.—*Lafayette.*—R. B. Wiley. ***Logansport.*—**F. N. Hatch.

IOWA. Total Membership, 22.

embers.—*Ames.*—A. Marston. ***Burlington.*—**F. D. H. Lawlor. ***Davenport*—**G. H. Boynton, W. E. Dauchy, C. Francis. ***Des Moines.*—**J. B. Marsh. ***Iowa City.*—**W. G. Raymond. ***Keokuk.*—**M. Meigs.

ssociate Members.—*Ames.*—J. E. Kirkham. ***Clinton.*—**R. C. Hart. ***Davenport.*—**W. H. Kimball. ***Des Moines.*—**P. Beer, L. G. Berry, C. H. Fuller, R. T. Hartman, J. E. Van Liew. ***Iowa City.*—**B. J. Lambert.

uniors.—*Ames.*—H. C. Ford. ***Des Moines.*—**M. DeM. Gates, I. D. Goodwin, S. Wilson. ***Iowa City.*—**F. C. Harper.

KANSAS. Total Membership, 31.

Members.—*Atchison.*—F. Giddings. ***Lawrence.*—**B. J. Dalton, W. McGrath, F. O. Marvin. ***Leavenworth.*—**E. H. Connor, W. H. Jones. ***Topeka.*—**C. F. W. Felt, E. W. Grant, C. A. Morse, A. A. Robinson, H. M. Stone.

Associate Members.—*Fort Leavenworth.*—J. H. Poole. ***Iola.*—**L. A. Hunt. ***Lawrence.*—**W. C. Hoad, H. A. Rice. ***Leavenworth.*—**E. H. Barkmann, J. O'Neil. ***Manhattan.*—**C. M. Buck, L. E. Conrad, W. S. Gearhart, W. J. Lightfoot. ***Marysville.*—**S. W. Henderson. ***Topeka.*—**L. B. Smith, J. Weidel. ***Wichita.*—**F. R. Berry.

Juniors.—*Fort Leavenworth.*—R. D. Black, O. L. Eltinge. ***Lawrence.*—**E. H. Dunmire. ***Leavenworth.*—**G. Kingsley. ***Topeka.*—**R. D. M. Henley. ***Wichita.*—**S. T. Harding.

KENTUCKY. Total Membership, 37.

Members.—*Earlington.*—J. B. Atkinson. ***Lexington.*—**W. D. Pickett. ***Louisville.*—**W. C. Brohm, W. H. Courtenay, S. F. Creecelius, J. L. Frazier,

W. Gazlay, W. E. Hutchings, J. M. Johnson, E. E. Kuersteiner, T. A. Leisen, R. Montfort, M. Morris, J. H. Peyton, G. W. Shaw, W. M. Venable, J. E. Willoughby, E. Zarbell. ***Middlesboro.***—W. E. Gunn. ***Newport.***—W. L. Glazier. ***St. Matthews.***—R. Fink. ***Thirteen.***—L. S. Johnson.

Associate Members.—***Eadsville.***—J. S. Butler. ***Louisville.***—W. G. Arn, W. D. Gray, L. W. Hancock, W. N. Morrill, H. S. Morse, J. H. L. Vogt. ***Newport.***—A. H. Horton. ***Thirteen.***—H. G. McCormick.

Associates.—***Louisville.***—J. B. Speed.

Juniors.—***Louisville.***—R. DeL. French, F. E. Hayes, Jr., J. B. Hutchings, Jr., A. A. Krieger.

Fellows.—***Louisville.***—W. R. Belknap.

LOUISIANA. Total Membership, 38.

Members.—***Alexandria.***—C. C. Crew, I. W. Sylvester. ***New Orleans.***—T. H. Barnes, L. H. Beach, A. C. Bell, A. L. Black, H. Burgess, J. F. Coleman, G. McC. Derby, C. Donovan, G. G. Earl, J. T. Eastwood, W. B. Gregory, W. J. Hardee, B. M. Harrod, J. C. Haugh, F. M. Kerr, W. E. Knobloch, S. F. Lewis, A. Perrilliat, A. L. Phillips, M. P. Robertson, C. W. Wood, W. B. Wright.

Associate Members.—***Bogalusa.***—C. R. Howard. ***Boyce.***—G. W. Hillman. ***Burrwood.***—J. B. Lindhé. ***Monroe.***—A. K. Downes. ***New Orleans.***—W. C. Barton, J. W. Billingsley, A. M. N. Blamphin, J. R. Hardesty, E. L. Jahncke, C. W. J. Neville, S. McC. Young.

Juniors.—***Boyce.***—R. L. Holmes. ***Harrisonburg.***—C. R. Hawley. ***New Orleans.***—O. Lake.

MAINE. Total Membership, 29.

Members.—***Augusta.***—C. C. Babb, H. F. Hill. ***Bangor.***—P. H. Coombs, G. H. Hamlin. ***Gardiner.***—F. Danforth. ***Houlton.***—M. Burpee. ***Lewiston.***—W. H. Sawyer. ***Millinocket.***—H. S. Ferguson. ***Portland.***—E. C. Jordan, G. A. Zinn. ***Rockland.***—O. H. Tripp. ***Rumford.***—C. A. Mixer. ***Veazie.***—J. A. Leonard.

Associate Members.—***Bangor.***—G. A. Hersey. ***Houlton.***—P. C. Newbegin. ***Madison.***—C. S. Humphreys. ***Millinocket.***—F. C. Bowler, H. P. Hoyt, J. W. Tower. ***Orono.***—H. S. Boardman. ***Portland.***—W. A. Clapp, W. H. Norris, H. H. Robinson. ***Searsport.***—J. H. Duncan. ***Sullivan Harbor.***—P. D. Simpson.

Juniors.—***Brunswick.***—H. B. Hastings. ***Gorham.***—O. McK. Moulton. ***Portland.***—R. Hazen, E. L. Lynch.

MARYLAND. Total Membership, 58.

Members.—***Baltimore.***—P. A. Beatty, H. A. Belden, H. D. Bush, M. Cohen, W. W. Crosby, B. T. Fendall, J. Fisher, H. Fox, J. E. Greiner, F. H.

Hambleton, C. W. Hendrick, C. A. Hook, W. D. Janney, W. L. Kenly, F. A. Kummer, O. F. Lackey, M. A. Long, J. N. Shannahan, W. F. Strouse, H. R. Talcott, T. M. Ward, F. S. Washburn. ***Catonsville.***—G. B. Hazlehurst. ***Darlington.***—J. H. Harlow. ***Frederick.***—J. L. Dodge. ***Hagerstown.***—J. B. Ferguson.

Associate Members.—***Annapolis.***—A. L. Parsons. ***Baltimore.***—G. D. Brooke, R. L. Burwell, R. L. Chamberlaine, E. D. Cummings, L. Dorsey, W. H. Dorsey, J. S. Doyle, W. R. Edwards, I. O. Harper, A. H. Hartman, J. M. Hood, Jr., H. A. Lane, T. D. Pitts, A. M. Quick, G. C. Saunders, L. F. Smith, A. W. Thompson, W. D. Uhler, G. W. C. Whiting, J. L. Wickes. ***Colgate.***—E. B. Whitman. ***Cumberland.***—H. Rittenhouse. ***Darlington.***—J. H. Harlow, Jr. ***Denton.***—H. A. Paine.

Juniors.—***Annapolis.***—E. T. Hayman. ***Baltimore.***—L. Bernstein, J. N. Mackall, W. W. Pagon, H. S. Regester, Jr., S. G. Smith. ***Chestertown.***—M. deK. Smith, Jr.

MASSACHUSETTS. Total Membership, 269.

Honorary Members.—***Lowell.***—H. F. Mills.

Members.—***Amherst.***—J. E. Ostrander. ***Boston.***—H. S. Adams, C. E. Alderman, C. F. Allen, N. F. Ambursen, H. B. Andrews, W. H. Arnold, T. Aspinwall, W. M. Bailey, F. A. Barbour, H. K. Barrows, W. I. Baucus, H. Bissell, D. Brackett, E. W. Branch, G. H. Brazer, F. Brooks, M. F. Brown, W. M. Brown, E. Burr, A. E. Burton, M. M. Cannon, H. H. Carter, A. S. Cheever, S. Child, W. L. Church, E. C. Clarke, W. W. Cummings, F. S. Curtis, H. C. Daggett, R. B. Davis, A. W. Dean, E. S. Dorr, H. P. Eddy, C. Eldridge, S. C. Ellis, G. C. Emerson, F. H. Fay, B. R. Felton, J. N. Ferguson, W. E. Foss, J. P. Frizell, F. L. Fuller, X. H. Goodnough, B. W. Guppy, W. H. Ham, G. E. Harkness, E. Harrington, H. C. Hartwell, H. W. Hayes, F. W. Hodgdon, J. L. Howard, E. W. Howe, G. E. Howe, D. C. Jackson, W. Jackson, W. S. Johnson, F. C. Kimball, G. A. Kimball, H. V. Macksey, C. T. Main, H. Manley, L. Metcalf, E. F. Miller, H. A. Miller, E. E. Pettee, A. L. Plimpton, D. Porter, J. R. Rablin, I. Rich, J. W. Rollins, Jr., W. Rotch, R. A. Shailer, F. E. Shedd, C. W. Sherman, F. A. Snow, J. P. Snow, W. P. Snow, C. M. Spofford, F. P. Stearns, L. A. Taylor, S. E. Tinkham, E. A. Tucker, E. K. Turner, G. R. Wadsworth, L. C. Wason, W. Watson, De W. C. Webb, W. Wheeler, F. O. Whitney, H. B. Wood, C. J. H. Woodbury, J. R. Worcester. ***Brookline.***—H. B. Burley, D. FitzGerald, A. H. French, H. Ropes, E. E. Stone, C. R. Suter. ***Cambridge.***—H. J. Hughes, L. J. Johnson, E. D. Leavitt, W. Martin, J. C. Moses, J. C. Scorgie, G. F. Swain. ***Chelsea.***—W. E. McClintock. ***Clinton.***—H. Parker. ***Dorchester.***—T. W. Baldwin, H. N. Cheney, F. A. McInnes, G. S. Morrill, J. E. Palmer, L. L. Street. ***Fall River.***—R. H. Beattie, B. T. Buffinton, A. Wolstenholme. ***Foxboro.***—F. J. Wood. ***Gloucester.***—H. W. Spooner. ***Haverhill.***—R. R. Evans. ***Hingham.***—W. H. Allen. ***Holyoke.***—E. P.

Butts, E. A. Ellsworth, J. L. Tighe. ***Hyde Park.***—E. A. W. Hammatt. ***Jamaica Plain.***—S. C. Heald. ***Lawrence.***—R. A. Hale, I. L. Sjöström. ***Lee.***—W. W. Maclay. ***Lowell.***—G. Bowers, A. T. Safford. ***Lynn.***—C. W. Gay. ***Malden.***—H. A. Carson, R. L. Read. ***Medford.***—G. Hodges. ***Melrose.***—C. T. Fernald. ***New Bedford.***—A. B. Drake, W. F. Williams. ***Newton.***—E. Sawyer. ***Newton Center.***—D. H. Andrews. ***Newton Highlands.***—S. E. Thompson. ***North Adams.***—F. B. Locke. ***Plymouth.***—W. H. Sears. ***Sandwich.***—C. L. Crandall, H. W. Durham, F. D. Fisher. ***Sharon.***—E. S. Safford. ***Somerville.***—W. F. Goodrich. ***South Yarmouth.***—C. H. Davis. ***Springfield.***—S. M. Green, G. N. Merrill, C. M. Slocum, D. M. Wheeler. ***Taunton.***—L. Dean. ***Tufts College.***—F. B. Sanborn. ***Turners Falls.***—C. W. Hazelton. ***Wakefield.***—G. M. Tompson. ***Walpole.***—W. L. Bowker. ***Waltham.***—B. Brewer, C. R. Perry. ***Westfield.***—O. E. Parks. ***West Newton.***—W. P. Morse, E. H. Rogers, H. D. Woods. ***West Roxbury.***—L. B. Manley. ***Worcester.***—C. A. Allen, R. H. Brown, W. E. Buck, A. W. French, E. F. Miner, S. H. Pitcher.

Associate Members.—***Boston.***—E. F. Atwood, W. T. Barnes, J. V. Beekman, Jr., E. P. Bliss, C. B. Breed, B. S. Brown, G. P. Carver, L. S. Cowles, F. W. Daggett, G. D. Emerson, J. K. Freitag, A. D. Fuller, R. D. Gardner, R. K. Hale, L. E. Hawes, H. K. Higgins, C. J. Hogue, T. W. Norcross, E. F. Rockwood, N. H. Sanderson, J. C. Schaeffler, A. L. Scott, E. B. Stearns, W. F. Steffens, F. L. Tibbetts, R. S. Weston, H. P. Wilson. ***Cambridge.***—W. L. Butcher, F. H. Carter, H. F. Howe, C. W. Killam, H. F. Sawtelle, J. Ware, N. R. Willard. ***Charlestown.***—E. C. Hayden. ***Clinton.***—E. R. B. Allardice. ***East Walpole.***—E. Hutchins. ***Elmwood.***—P. M. Churchill. ***Fall River.***—W. E. Noble. ***Fitchburg.***—F. C. Davis. ***Gleasondale.***—W. C. Lambert. ***Holyoke.***—A. F. Sickman. ***Housatonic.***—J. M. Race. ***Ludlow.***—C. E. Quinby. ***Malden.***—W. E. Barnes, W. J. Mozart. ***Nantucket.***—H. M. Harps. ***New Bedford.***—I. M. Chace, Jr., R. D. Chase, W. H. Chase. ***Pittsfield.***—H. L. Dunn, A. B. Farnham, C. B. Lindholm, E. R. Simpson, M. M. Thrane. ***Quincy.*** P. Lawton. ***Sandwich.***—A. S. Ackerman. ***South Framingham.***—W. W. Locke. ***South Hadley Falls.***—M. J. Leahy. ***Springfield.***—E. E. Lochridge, R. Y. Patterson. ***Tufts College.***—E. H. Rockwell. ***Waltham.***—C. H. Dutton, H. B. Pratt. ***Westfield.***—J. L. Hyde. ***West Roxbury.***—C. R. Gow. ***Winthrop.***—G. M. Stevens. ***Worcester.***—C. M. Allen, V. P. Curtis, L. B. Jenckes, S. A. Stephenson, Jr.

Associates.—***Boston.***—C. H. Eglee, H. W. Hayward, H. A. Phillips. ***Newtonville.***—L. E. Moore. ***Pittsfield.***—E. T. Belden. ***West Chelmsford.***—J. J. Monahan.

Juniors.—***Boston.***—C. S. Allen, E. W. Bowditch, J. E. Cunningham, G. Johnson, W. E. Lydston, R. A. Martinez, W. B. Thomson. ***Cambridge.***—J. R. Nichols, A. W. Nordwell. ***East Walpole.***—A. C. Johnston. ***Hyde Park.***—W. W. Clifford. ***Lowell.***—H. B. Coburn, Jr. ***Malden.***—C. R. Turner. ***Middleboro.***—F. S. Weston. ***Mundale.***—A. C. King. ***Newton***

Center.—R. G. Tyler. ***Newton Highlands.***—W. O. Lichtner. ***Waltham.***—G. Small. ***Worcester.***—H. C. Ives.

ellows.—***Swampscott.***—S. Holman.

MICHIGAN. Total Membership, 87.

embers.—***Ann Arbor.***—J. B. Davis, E. D. Rich, G. S. Williams. ***Detroit.***—A. B. Atwater, F. T. Barcroft, B. Douglas, A. Dow, H. H. Esselstyn, G. H. Fenkell, J. D. Hawks, H. S. Hodge, J. C. Hutchins, C. Keller, G. H. Kimball, W. S. Kinnear, R. H. McCormick, T. F. McCrickett, F. G. Ray, C. McD. Townsend, J. A. Ubsdell, Jr., H. A. E. C. von Schon, G. H. Webb, E. S. Wheeler, S. D. Williams, Jr. ***Grand Rapids.***—E. H. Barnes, L. W. Goddard, F. W. Lehnartz, D. McCool, J. J. McVean, K. S. Riser. ***Grosse Ile.***—F. B. Howard. ***Harbor Beach.***—E. J. Duffies. ***Jackson.***—W. G. Fargo, R. M. Newman. ***Kalamazoo.***—G. S. Pierson. ***Lapeer.***—F. Morley. ***Manistee.***—E. W. Muenscher. ***Marquette.***—R. C. Young. ***Sault Ste. Marie.***—I. De Young, W. J. Graves, L. C. Sabin. ***South Haven.***—A. J. Wenzell.

ssociate Members.—***Ann Arbor.***—C. A. Ellis, A. E. Greene, J. H. Griffith, H. B. Merrick, C. J. Tilden. ***Detroit.***—W. Burton, G. R. Cooke, J. E. Evans, A. C. Everham, G. S. Gildersleeve, M. Goldenberg, W. S. Hazelton, J. Kahn, P. M. Louwerse, M. S. MacDiarmid, L. Möller, E. C. Soper, E. M. Walker. ***Grand Rapids.***—G. M. Ames, W. S. Bake. ***Houghton.***—G. H. Banks. ***Rochester.***—L. H. Egan.

ssociates.—***Ann Arbor.***—H. H. Atwell. ***Grand Rapids.***—F. L. Gaines. ***Saginaw.***—G. L. Burrows.

uniors.—***Ann Arbor.***—L. E. Ayres, A. J. Decker, C. J. Green, H. K. Holland, G. H. Knutson, C. W. Spooner. ***Benton Harbor.***—C. E. Chappell. ***Detroit.***—J. T. Lillich, R. A. Reynolds, W. C. Taylor, R. R. Tinkham. ***Flint.***—C. I. Auten. ***Grand Rapids.***—R. E. Harrison. ***Grosse Ile.***—N. R. Macklem. ***Ishpeming.***—C. B. Hawley. ***Jackson.***—W. W. Tefft. ***Menominee.***—R. S. Gram. ***Sault Ste. Marie.***—W. M. Rich, S. D. Strong. ***Wells.***—G. T. Stephenson.

MINNESOTA. Total Membership, 57.

embers.—***Albany.***—S. Wimmer. ***Duluth.***—C. Coleman, J. H. Darling, G. D. Fitch, F. E. House, T. F. McGilvray, D. A. Reed, G. A. Taylor. ***Hopkins.***—F. W. Cappelen. ***International Falls.***—H. C. Ash. ***Minneapolis.***—F. H. Constant, W. de la Barre, J. T. Fanning, L. S. Gillette, J. B. Gilman, W. S. Hewett, G. M. Huss, W. D. Lovell, C. H. Prior, F. C. Shenehon, H. E. Stevens, G. W. Sublette, C. A. P. Turner, G. H. White, G. L. Wilson. ***St. Paul.***—C. Le R. Annan, R. B. C. Bement, O. Claussen, W. L. Darling, J. R. W. Davis, A. H. Hogeland, G. H. Hutchinson, C. J. A. Morris, L. W. Rundlett, D. C. Shepard, H. E. Stevens.

ssociate Members.—***Duluth.***—F. A. Cokefair, W. G. Zimmermann. ***Eyota.***—C. F. Brush. ***Minneapolis.***—F. H. Bass, W. P. Cowles, F. M. Henry,

S. G. Jones, W. B. Newhall, R. D. Thomas. ***St. Paul.***—J. G. L. Cu ningham, R. Follansbee, R. Hamlin, J. C. Sesser, P. E. Stevens, J. Stewart, M. J. Thompson, M. Toltz.

Associates.—*St. Paul.*—H. Elliott.

Juniors.—*Hibbing.*—W. F. Collar. ***Minneapolis.***—E. H. Bruntlett.

Fellows.—*St. Paul.*—J. J. Hill.

MISSISSIPPI. Total Membership, 22.

Members.—*Clarksdale.*—A. L. Dabney, T. G. Dabney. ***Gautier.***—J. Lindsey, Jr. ***Greenville.***—A. Hider, R. Somerville, C. H. West. ***Jacl son.***—W. G. Kirkpatrick. ***Natchez.***—E. B. Geddes. ***Vicksburg.***—H. M Marshall, A. M. Todd, E. C. Tollinger.

Associate Members.—*Vicksburg.*—E. S. Maupin, A. A. Woods.

Juniors.—*Columbus.*—C. E. Apple. ***Greenville.***—W. E. Elam. ***Vicksbur*** —P. E. Cunningham, A. W. Dann, F. Eberspacher, G. P. F. Jouine, R. Lilly, R. L. Tatum, T. T. Wright.

MISSOURI. Total Membership, 164.

Members.—*Columbia.*—C. Hill, A. L. Hyde, F. P. Spalding. ***Independenc*** —E. M. Stayton. ***Kansas City.***—E. J. Beard, A. M. Blodgett, D. Bo tecou, C. S. Burns, W. W. Colpitts, H. A. Fitch, S. W. Fox, J. V. Hann E. A. Harper, J. L. Harrington, I. G. Hedrick, F. W. Honens, J. V Hoover, W. Kiersted, J. A. Lahmer, R. J. McCarty, R. E. McDonnel A. Maitland, Jr., M. P. Paret, H. K. Seltzer, J. H. Smith, H. F. Taylo L. Treadwell, A. A. Trocon, J. A. L. Waddell, R. W. Waddell. ***Marcelin*** —G. J. Bell. ***Rolla.***—E. G. Harris. ***St. Louis.***—W. H. Bixby, W. Brenneke, B. L. Brown, W. Buehler, M. L. Byers, O. W. Childs, B. Colby, A. O. Cunningham, E. B. Fay, E. C. Finley, S. B. Fisher, E. Fla R. P. Garrett, C. Gayler, F. T. Hatch, J. F. Hinckley, M. L. Holma J. R. Hudson, A. L. Johnson, F. G. Jonah, C. H. Ledlie, B. McKee J. A. McKim, R. E. McMath, C. V. Mersereau, C. H. Miller, W. Mitchell, R. Moore, F. Neher, J. A. Ockerson, F. Y. Parker, H. Phillip R. H. Phillips, J. Pitzman, C. de la C. Purdon, H. L. Reber, H. Rohwe S. B. Russell, H. P. Taussig, J. L. Van Ornum, R. L. Van Sant, E. Wall, J. W. Woermann. ***Sulphur Springs Landing.***—C. F. Stephens.

Associate Members.—*Columbia.*—E. B. Cauthorn, R. F. Moss, W. S. Williams ***Joplin.***—J. B. Hodgdon. ***Kansas City.***—L. R. Ash, R. C. Barnett V. H. Cochrane, F. G. Cudworth, J. C. Herring, E. E. Howard, F. D Hughes, R. E. Koon, J. C. Long, B. Lowther, P. McGeehan, A. M. Meyers C. N. Miller, C. A. Slayton, W. W. K. Sparrow, H. P. Treadway, H. vo Unwerth, J. S. Worley. ***St. Louis.***—J. H. Alexander, P. Aylett, G. S Bergendahl, J. M. Bischoff, G. G. Black, H. E. Boardman, S. W. Bowen F. D. Collins, R. S. Colnon, J. E. Conzelman, H. M. Cryder, E. C. Dicke C. H. Fisk, R. H. P. Ford, J. T. Garrett, E. Gray, W. T. Gray, A. P

Greensfelder, F. P. Hamilton, V. K. Hendricks, L. Highley, F. A. Jones, A. E. Lindau, R. L. Lund, R. McCulloch, R. Morey, R. L. Murphy, A. T. North, H. J. Pfeifer, G. A. Pierce, C. L. Post, W. H. Prentice, Jr., H. Rusch, J. W. Skelly, W. A. Tyrrell, A. M. Vance, L. R. Whitted, F. L. Wilcox. ***Springfield.***—H. P. Mobberly. ***Webb City.***—J. C. Barr, W. E. Smith.

Associates.—*St. Louis.*—E. C. Constance, H. Struckmann, H. von Schrenk.

Juniors.—*Columbia.*—A. R. Eitzen, E. Querbach. ***Fruitville.***—L. L. Winans. ***Kansas City.***—S. Hardesty, C. A. Neal, N. T. Veatch, Jr., H. C. Westover. ***Kirkwood.***—H. H. Clayton. ***Macon.***—F. C. Huntsman, LeR. D. Williams. ***Rolla.***—F. E. Dennie. ***St. Louis.***—W. J. Burton, W. W. Horner, C. P. Howes, W. J. Knight, J. M. Peters, J. C. Pritchard, M. Schuyler, A. I. Stiles, J. E. Teal, H. C. T. Toensfeldt, R. L. Williams.

MONTANA. Total Membership, 33.

Members.—*Butte.*—E. Carroll, W. H. Penfield, E. H. Wilson. ***Family.***—G. E. Goodwin. ***Fort Shaw.***—S. B. Robbins. ***Glendive.***—J. Wright. ***Great Falls.***—F. Scotten. ***Helena.***—M. H. Gerry, Jr., M. S. Parker, H. N. Savage. ***Huntley.***—M. E. Reed. ***Malta.***—C. P. Williams. ***Missoula.***—F. Beckwith. ***St. Ignatius.***—E. F. Tabor.

Associate Members.—*Augusta.*—C. B. Long. ***Billings.***—C. E. Shipman. ***Birney.***—L. M. Holt. ***Browning.***—E. C. Gersbach. ***Butte.***—D. H. Campbell. ***Fort Shaw.***—H. O. Beale. ***Glendive.***—L. H. Mitchell, R. S. Stockton. ***Helena.***—R. M. Conner, R. O. Hayt. ***Holter.***—H. J. Wild. ***Ridgelawn.***—G. L. Davis. ***Valier.***—J. B. Bond.

Juniors.—*Babb.*—C. E. Hayes. ***Fort Shaw.***—F. Towle. ***Glendive.***—R. T. Hurdle. ***Helena.***—W. A. Lamb. ***Miles City.***—G. C. Pruett. ***St. Ignatius.***—L. D. Graham.

NEBRASKA. Total Membership, 19.

Members.—*Lincoln.*—F. T. Darrow, A. Dobson, G. S. Walsh. ***Omaha.***—W. A. Ayerigg, G. L. Campen. ***Scottsbluff.***—B. Ehle. ***South Omaha.***—W. S. King.

Associate Members.—*Falls City.*—J. A. Crook. ***Mitchell.***—R. S. Carberry, A. Weiss. ***Nebraska City.***—A. M. Munn. ***Omaha.***—A. C. Arend, G. J. S. Collins, G. W. Craig, A. M. Crain, H. A. Holdrege, A. C. Koenig, R. A. Swartwout.

Juniors.—*Omaha.*—R. E. Mieth.

NEVADA. Total Membership, 6.

Members.—*Fallon.*—T. H. Means. ***McGill.***—L. Duncan.

Associate Members.—*Fallon.*—L. W. Hall. ***Reno.***—E. B. Bumsted, C. G. Tudor.

Juniors.—*Mazuma.*—G. G. McDaniel.

NEW HAMPSHIRE. Total Membership, 9.

Members.—*Derry Village.*—J. C. Chase. ***Hanover.*—**R. Fletcher. ***Little Boar's Head.*—**W. H. Jaques. ***Manchester.*—**H. A. Herrick. ***Portsmouth.*—**L. E. Gregory.

Associate Members.—*Berlin.*—G. F. Lovett.

Associates.—*Hanover.*—J. V. Hazen, C. A. Holden.

Juniors.—*Concord.*—J. H. Stone.

NEW JERSEY. Total Membership, 183.

Members.—*Allenhurst.*—E. B. Gumaer. ***Andover.*—**G. Leighton. ***Atlantic City.*—**J. W. Hackney. ***Atlantic Highlands.*—**W. S. Auchincloss. ***Bayonne.*—**F. H. Baldwin, G. F. Morse. ***Bogota.*—**St. J. Clarke. ***Bound Brook.*—**H. M. Herbert. ***Bridgeton.*—**O. Smith. ***Camden.*—**H. C. Felton, DeC. May, E. H. Sapp. ***Cape May Court House.*—**F. W. Bennett. ***East Orange.*—**E. I. Cantine, A. Carr, W. H. V. Reimer, G. W. Swinburne, W. M. Torrance. ***East Rutherford.*—**W. F. Kauffmann. ***Elizabeth.*—**J. L. Bauer, W. H. Luster, Jr. ***Flanders.*—**C. G. Force. ***Glen Ridge.*—**A. H. Tyson. ***Highlands.*—**C. W. Raymond. ***Hoboken.*—**T. H. McCann, G. J. Ray, W. F. Whittemore. ***Jersey City.*—**M. L. Gardner, E. W. Harrison, C. A. Van Keuren, J. Waterhouse. ***Mahwah.*—**LaF. Olney. ***Montclair.*—**G. B. Cornell, F. D. Leffingwell. ***Morristown.*—**H. J. Cole. ***Newark.*—**R. E. Danforth, W. P. Field, J. H. Gregory, J. C. Hallock, W. N. Hazen, H. A. Hickok, G. Lehlbach, J. Owen, J. H. Philips, A. M. Reynolds, J. M. Schreiber, M. R. Sherrerd, W. G. Taylor. ***Passaic.*—**J. H. Edwards, A. B. Proal, Jr., C. R. Wise. ***Paterson.*—**W. W. Christie, J. H. Cook, J. W. Ferguson, E. LeB. Gardner, A. E. Schneeweiss. ***Phillipsburg.*—**P. H. De Witt. ***Plainfield.*—**R. C. Brown, R. H. Hood, C. G. E. Larsson, F. Mason, W. F. Merrill. ***Princeton.*—**C. McMillan. ***Red Bank.*—**G. McC. Taylor. ***Roselle.*—**G. P. Janes. ***South Orange.*—**A. Coffin, J. B. Duncklee. ***Summit.*—**C. P. Bassett. ***Tenafly.*—**W. G. Clark, H. O. Pond. ***Trenton.*—**C. E. Hewitt. ***Upper Montclair.*—**C. A. Mead.

Associate Members.—*Andover.*—H. E. Wagner, C. S. Wolcott. ***Arlington.*—**W. S. Logan, J. F. Scrimshaw. ***Atlantic City.*—**J. H. Decker, A. H. Nelson, E. D. Rightmire. ***Bayonne.*—**F. W. Dalrymple, J. L. Gray, L. R. Shellenberger. ***Bordentown.*—**E. G. Kastenhuber, Jr. ***Camden.*—**C. F. Class, C. W. Thorn. ***Cranford.*—**J. C. Park. ***East Orange.*—**J. W. Buzzell, F. B. Nelson, S. J. Ott, A. A. Reimer, F. A. Reimer, C. H. Splitstone. ***Elizabeth.*—**T. C. Fischer. ***Fanwood.*—**R. L. G. Meggy. ***Flemington.*—**P. I. Craig. ***Hackensack.*—**E. W. Stevens. ***Hoboken.*—**B. H. Davis, J. W. Obreiter. ***Hudson Heights.*—**C. E. Brown. ***Jersey City.*—**C. W. Bance, A. S. Hamill, C. H. Higgins, G. W. Kinne, J. P. McLean, A. L. Moorshead, T. J. Wasser, N. D. Wortendyke.

Little Falls.—H. E. Van Ness. ***Maurer.***—C. N. Forrest. ***Montclair.***—G. Immediato, S. Johannesson, A. E. Owen. ***Morristown.***—C. H. Stengel. ***Newark.***—L. A. Ball, J. S. Crane, E. R. Halsey, J. W. Heller, W. A. Howell, H. B. Hurlbut, H. P. Kreiner, L. A. Robb, F. Rosenberg, M. N. Shoemaker. ***New Brunswick.***—W. S. Greene. ***Paterson.***—A. W. Cuddeback, H. J. Hewat, J. E. Torrey. ***Perth Amboy.***—R. L. Fowler, S. J. Mason, F. L. Smith. ***Phillipsburg.***—R. P. Howell. ***Plainfield.***—De W. D. Barlow, R. B. Titsworth, W. B. Travell, A. M. Zabriskie. ***Rahway.***—J. J. Vail. ***Raritan.***—P. H. Spear. ***Red Bank.***—T. H. Grant. ***South Orange.***—I. Hawkins, C. T. Schwarze. ***Trenton.***—W. B. Bamford, N. A. K. Bugbee, L. Focht, A. C. Gregory, I. Harby, A. Hirst. ***Weehawken.***—G. W. Bond, Jr. ***West New York.***—D. W. Krellwitz.

Associates.—***Bound Brook.***—J. I. Livingston. ***Burlington.***—W. R. Conard. ***Dumont.***—S. S. Bogart. ***East Orange.***—J. A. Dailey. ***Franklin Furnace.***—J. F. Wrenn. ***Glen Ridge.***—F. M. Talbot. ***Jersey City.***—J. J. Ferris. ***Newark.***—M. Watson. ***Old Bridge.***—J. M. Lally. ***Plainfield.***—E. L. Ransome. ***Princeton.***—H. S. S. Smith, F. N. Willson. ***Ridgewood.***—G. La P. Denio.

Juniors.—***Asbury Park.***—G. C. Tutherly. ***Atlantic City.***—G. L. Watson. ***Bayonne.***—S. J. Harwi. ***Beverly.***—E. K. Cortright. ***Cliffside Park.***—S. W. McClave, Jr. ***Hackensack.***—W. G. Broadhurst. ***Jersey City.***—H. D. Allen, W. V. McMenimen, A. F. Sauer, J. L. Vogel. ***Montclair.***—K. D. Owen. ***Morristown.***—W. R. Tyler. ***Newark.***—F. H. Earle, Jr., E. A. Ward. ***Newton.***—F. E. Caldwell. ***Passaic.***—R. S. Wise. ***Paterson.***—H. S. Speidel. ***Plainfield.***—C. Gilman. ***Trenton.***—J. N. Brooks, H. Le R. Fryer. ***Weehawken Heights.***—W. A. Yeo.

Fellows.—***Landing.***—J. Watson.

NEW MEXICO. Total Membership, 7.

Members.—***Engle.***—J. A. French, H. J. Gault. ***Raton.***—O. H. B. Turner. ***Silver City.***—H. F. Labelle.

Associate Members.—***Albuquerque.***—H. F. Robinson. ***Aztec.***—O. J. Turley.

Juniors.—***Selden.***—E. Patterson.

NEW YORK. Total Membership, 1 484.

Members.—***Albany.***—H. Andrews, M. G. Barnes, H. A. Benedict, H. K. Bishop, E. A. Bond, G. H. Burgess, E. E. Haslam, W. R. Hill, T. Horton, W. B. Landreth, W. McCulloh, W. R. Marden, C. T. Middlebrook, H. C. Parsons, J. Ripley, C. S. Sims, G. F. Stickney, C. F. Stowell, A. H. Sutermeister, J. Thornley, E. A. Touceda, E. F. Van Hoesen, D. A. Watt. ***Albion.***—S. Hazard. ***Amsterdam.***—F. E. Crane, F. P. Williams. ***Andes.***—J. A. Kelley. ***Auburn.***—J. W. Ackerman. ***Ballston.***—H. M. Geer. ***Brewerton.***—C. W. Sturtevant. ***Broadalbin.***—W. P. Judson. ***Brooklyn.***—H. R. Asserson, V. B. Bergen, A. S. F. Berquist, G. Berry, C. Blake,

R. W. Creuzbaur, P. P. Farley, C. L. Fitch, W. G. Ford, E. J. Fort, W. H. Gahagan, W. G. Gove, C. R. Grimm, G. T. Hammond, S. U. Hopkins, G. Kaufman, F. McD. Leavitt, A. McLean, J. C. Meem, W. S. Menden, L. V. Morris, H. L. Potter, C. B. Rowland, T. F. Rowland, Jr., R. L. Russell, G. S. Skilton, C. W. Smith, H. C. Stowe, J. Strachan, E. C. Swezey, G. A. Taber, W. R. Tenney, G. A. Tibbals, S. G. Tibbals, C. J. Wolfe. ***Brown Station.***—C. E. Davis, J. S. Langthorn, M. J. Look. ***Buffalo.***—C. A. Alderman, F. M. Ashmead, F. V. E. Bardol, G. B. Bassett, C. S. Boardman, C. C. Conkling, L. LeR. Davis, G. S. Field, S. J. Fields, W. L. Fisk, F. V. Greene, E. B. Guthrie, W. A. Haven, E. Hayes, S. T. M. B. Kielland, L. H. Knapp, E. Low, E. P. Lupfer, H. L. Lyon, C. G. Moore, C. M. Morse, J. C. Quintus, G. A. Ricker, G. T. Roberts, T. G. Smith, J. F. Witmer. ***Catskill.***—J. W. Kittrell, C. H. Van Orden. ***Chatham.***—W. P. Boright. ***Cooperstown.***—J. K. Choate. ***Dansville.***—E. T. Scovill. ***Dongan Hills.***—W. Boecklin. ***Elmira.***—E. E. Buchanan. ***Elmira Heights.***—H. W. Preston. ***Far Rockaway.***—C. R. Bettes. ***Fishkill.***—J. D. Fouquet. ***Fort Edward.***—E. V. R. Payne. ***Fort Totten.***—M. F. Bonzano. ***Geneva.***—C. T. Church, G. E. Ellis, S. W. Hayes. ***Groton.***—E. A. Landon. ***Hillburn.***—W. B. Lee. ***Hornell.***—R. S. Parsons. ***Irvington.***—W. Katté. ***Islip.***—E. R. Smith. ***Ithaca.***—C. L. Crandall, E. E. Haskell, E. Hayes, D. A. Molitor, H. N. Ogden. ***Jamaica.***—F. Auryansen, T. J. Carlile, O. Erlandsen, R. Evans, J. J. McLaughlin, J. R. Savage. ***Jamestown.***—E. C. Burns. ***Kingston.***—F. K. Betts, E. B. Codwise. ***Linoleumville.***—D. N. Melvin. ***Long Island City.***—W. C. Briggs, H. K. Endemann, W. T. Gould, G. A. Just, L. C. L. Smith. ***Lyons Falls.***—H. Constable. ***Massena.***—I. G. Calderwood, J. W. Rickey. ***Mechanicsville.***—R. P. Bloss. ***Medina.***—J. B. Goodwin. ***Middletown.***—E. Canfield, C. E. Knickerbocker. ***Montezuma.***—J. G. Palmer. ***Mt. Vernon.***—C. A. Hammond. ***New Brighton.***—J. T. Fetherston, T. S. Oxholm, J. D. Van Buren. ***Newburgh.***—E. Garrison. ***New Hartford.***—A. M. Scripture. ***New Paltz.***—T. P. Kinsley, W. R. Neely. ***New Rochelle.***—H. Crosby, H. G. Stott, H. A. Van Alstyne, J. K. Wilkes, C. W. S. Wilson. ***New York City.****—F. W. Abbot, E. L. Abbott, W. I. Aims, H. C. Alden, T. H. Alison, C. H. Allen, K. Allen, W. A. Allen, R. F. Almirall, G. Aus, W. E. Austin, H. N. Babcock, H. C. Baird, C. H. Baker, W. E. Baker, W. J. Baldwin, G. P. Bard, J. G. Basinger, G. S. Baxter, R. J. Beach, J. W. Beardsley, J. M. Belknap, W. E. Belknap, J. A. Bensel, K. Berle, R. T. Betts, E. J. Beugler, A. W. K. Billings, W. M. Black, F. O. Blackwell, F. Blossom, J. Bogart, A. P. Boller, R. P. Bolton, G. W. Booth, A. L. Bowman, J. C. Boyd, J. H. Brace, J. C. Brackenridge, F. E. Bradley, O. Brainard, G. W. Bramwell, J. Breuchaud, J. A. Briggs, A. G. Brinckerhoff, C. O. Brown, L. L. Brown, P. G. Brown, T. E. Brown, W. P. Brown, J. L. Brownlee, C. W. Bryan, C. W. Buchholz, R. S. Buck, G. B. Burbank, F. A. Burdett, A. S. Burgess, W. H. Burr, H. G. Burrowes, L. Bush, Le R. H. Byam, G. B. Caldwell, L. J. Carmalt, A. W. Carpenter, R. H.

---

* Includes the Boroughs of Manhattan and the Bronx.

Chambers, T. F. Chappell, J. E. Childs, G. L. Christian, G. L. Christy, F. B. Church, G. H. Clark, T. S. Clark, G. C. Clarke, T. C. Clarke, J. B. Clermont, T. A. Coffin, B. C. Collier, F. Collingwood, D. C. N. Collins, R. G. Collins, Jr., C. K. Conard, S. P. Connor, F. S. Cook, R. D. Coombs, S. E. Coombs, H. L. Cooper, T. Cooper, J. N. H. Cornell, A. B. Corthell, A. S. Crane, C. A. Crane, A. Craven, W. W. Crehore, B. F. Cresson, Jr., J. L. Crider, F. Crowell, S. Dahm, A. H. Dakin, Jr., R. T. Dana, J. V. Davies, A. L. Davis, C. Davis, I. M. de Varona, G. Devin, S. L. F. Deyo, E. Diebitsch, D. Y. Dimon, B. C. Donham, W. T. Dougan, H. F. Dunham, L. A. Dunham, J. O. Eckersley, H. W. Edwards, O. M. Eidlitz, J. A. Emery, W. W. Ewing, M. S. Falk, G. P. Farley, J. M. Farley, H. H. Farnum, L. N. Farnum, H. Farrington, G. R. Ferguson, A. D. Flinn, A. P. Folwell, P. D. Ford, J. Forgie, F. E. Foss, E. H. Foster, G. B. Francis, C. E. Fraser, J. B. French, A. I. Frye, J. H. Fuertes, G. W. Fuller, W. B. Fuller, F. W. Gardiner, L. P. Gaston, M. Gay, G. Gibbs, G. E. Gifford, R. Giles, R. H. Gillespie, E. P. Goodrich, W. C. Gotshall, C. B. Grady, C. H. Graham, J. H. Granbery, J. H. Gray, G. S. Greene, Jr., C. E. Grunsky, C. A. Hague, S. S. Haight, J. P. Hallihan, J. W. Hamilton, W. G. Hamilton, J. F. Hammond, R. R. Hancock, C. Hansel, W. J. Harahan, G. F. Hardy, A. Haring, C. L. Harrison, F. L. Hartigan, H. Hartwell, G. A. Harwood, W. J. Haskins, A. Haviland, J. B. Hayden, G. S. Hayes, A. Hazen, P. W. Henry, R. Hering, C. Herschel, V. H. Hewes, B. H. M. Hewett, E. R. Hill, G. Hill, A. L. A. Himmelwright, F. C. Hitchcock, S. W. Hoag, Jr., J. G. Hocke, H. W. Hodge, O. Hoff, N. B. K. Hoffman, J. B. Holbrook, E. H. Holden, F. de P. Hone, D. L. Hough, O. E. Hovey, H. J. Howe, C. W. Hudson, A. C. Humphreys, C. W. Hunt, C. T. Hutchinson, C. M. Ingersoll, Jr., C. M. Jacobs, H. Japp, E. S. Jarrett, H. C. Keith, W. D. Kelley, J. J. Kennedy, G. W. Kittredge, E. Klapp, J. M. Knap, W. H. Knight, J. A. Knighton, S. B. Knox, E. Kuichling, H. A. La Chicotte, R. Lamb, J. Langton, F. P. Lant, H. N. Latey, F. Lavis, C. W. Leavitt, Jr., E. Lentilhon, M. Lewinson, N. P. Lewis, J. W. Lieb, Jr., G. Lindenthal, F. T. Llewellyn, J. A. Lockwood, H. Loomis, L. F. Loree, H. C. Lowrie, A. Lucius, J. Lundie, O. S. Lyford, Jr., C. Macdonald, H. B. Machen, R. A. McCulloch, J. E. McKay, A. R. McKim, T. J. McMinn, G. W. McNulty, N. L. Malmros, A. P. Man, E. G. Manahan, H. H. Marden, Jr., R. A. Marshall, K. L. Martin, M. Merriman, W. C. Merryman, R. D. Mershon, F. Miller, H. C. Miller, R. P. Miller, S. Miller, O. E. Mogensen, L. S. Moisseiff, F. Molitor, C. H. Moore, F. F. Moore, D. E. Moran, W. C. Morris, W. S. Morton, W. Mueser, C. L. de Muralt, C. H. Myers, C. H. Nichols, A. Noble, E. P. North, P. E. Nostrand, J. H. O'Brien, H. L. Oestreich, E. E. Olcott, A. E. Olmsted, S. B. Opdyke, Jr., J. F. O'Rourke, G. A. Orrok, J. O. Osgood, J. C. Ostrup, R. G. Packard, C. J. Parker, W. C. Parmley, B. H. Parsons, H. de B. Parsons, W. B. Parsons, T. Paschke, W. A. Payne, F. S. Pearson, G. H. Pegram, J. J. Pemoff, G. Perrine, T. Pettigrew, W. C. Phelps, F. E. Pierce, C. DuB. Pollock, H. H. Porter, G. B. Post, H. W. Post, C. V. V. Powers, H. G. Prout, F. L. Pruyn, C. T. Purdy, E. R. Quinby, H. de Raasloff, J. Ramsey, Jr.,

W. B. Reed, G. S. Rice, C. Richardson, T. F. Richardson, L. D. Rights, J. W Ripley, A. A. Robbins, E. P. Roberts, G. H. Rogers, G. Rohrer, E. J Rosencrans, E. M. T. Ryder, W. L. Saunders, R. W. Sayles, A. Schaeffer M. E. Schmidt, H. B. Seaman, D. C. Serber, G. Sergeant, Jr., G. F Simpson, F. W. Skinner, W. G. Sloan, A. Smith, A. M. Smith, F. P Smith, J. W. Smith, W. M. Smith, T. E. Snook, C. H. Snow, J. B. Snow G. D. Snyder, O. Sonne, C. Sooysmith, G. A. Soper, J. F. Sorzano, W. E Spear, E. G. Spilsbury, A. N. Spooner, F. J. Sprague, J. H. Staats R. P. Staats, C. W. Staniford, F. McM. Stanton, R. B. Stanton, M. G Starrett, E. W. Stern, J. M. Stewart, L. B. Stillwell, G. C. Stoddard, M. R. Strong, A. A. Stuart, F. L. Stuart, F. S. Tainter, C. F. Taylor, E. Thacher, H. C. Thompson, S. C. Thompson, J. Thomson, T. K. Thomson, G. W. Tillson, R. H. Tingley, E. De V. Tompkins, F. M. Towl, S. Towle, L. L. Tribus, W. G. Triest, A. W. Trotter, C. E. Trout, L. W. Tucker, R. F. Tucker, W. C. Tucker, D. L. Turner, G. R. Tuska, A. S. Tuttle, C. C. Upham, B. R. Value, J. G. Van Horne, E. M. Van Norden, J. Van Vleck, E. Van Winkle, E. B. Van Winkle, G. W. Vaughan, M. A. Vielé, C. B. Voree, M. Waddell, J. E. Wadsworth, J. C. Wait, G. B. Waite, S. P. Waldron, C. I. Walker, J. F. Wallace, J. H. Wallace, C. D. Ward, A. L. Webster, E. Wegmann, S. C. Weiskopf, J. H. Wells, S. Whinery, G. C. Whipple, J. G. White, W. M. White, W. H. Wiley, W. J. Wilgus, E. G. Williams, F. S. Williamson, P. B. Windsor, F. P. Witmer, H. S. Wood, S. H. Woodard, C. Worthington, J. B. Wright, P. Yeatman, W. B. Yereance. H. W. York, M. A. Zook. ***Niagara Falls.***—J. L. Harper, C. H. Moritz, O. B. Suhr, A. H. Van Cleve. ***Norwich.***—E. F. Musson. ***Olean.***—G. T. Keith. ***Oswego.***—J. C. Churchill. ***Otisville.***—A. G. Norton. ***Peekskill.***—A. E. Kastl, A. A. Sproul. ***Port Chester.***—F. S. Odell, H. M. Rood. ***Poughkeepsie.***—A. S. Ives, R. Ridgway. ***Richmond Hill.***—J. E. Breen, R. C. Strachan. ***Rochester.***—J. F. Alden, T. W. Barrally, O. F. Bellows, E. A. Fisher, E. J. Govern, J. H. Grant, W. R. W. Griffin, W. E. Hoyt, J. Y. McClintock, T. J. Morrison, A. M. Mosscrop, W. N. Radenhurst, A. J. Rockwood, J. F. Skinner, H. M. Sperry. ***Rockville Center.***—W. D. Lockwood, B. M. Wagner. ***Rome.***—C. C. Hopkins, C. W. Knight. ***Rushford.***—C. H. Kendall. ***St. George.***—W. R. Hillyer. ***Schenectady.***—J. L. FitzGerald, G. S. Hook, O. H. Landreth, W. B. Potter, J. V. Rockwell, D. B. Rushmore. ***Sylvan Beach.***—A. F. Woolley. ***Syracuse.***—H. C. Allen, C. A. Bowman, H. B. Brewster, W. B. Cogswell, G. D. Holmes, C. O. McComb, T. H. Mather, G. Moulton, F. J. Schnauber, H. E. Smith, H. Soule. ***Tarrytown.***—D. S. Merritt. ***Tomkins Cove.***—P. K. Yates. ***Tompkinsville.***—C. L. Potter. ***Troy.***—J. Burden, E. R. Cary, C. B. Davis, J. Flynn, Jr., E. L. Grimes, T. R. Lawson, G. S. Leavenworth, J. A. Powers, P. C. Ricketts. ***Utica.***—C. L. Allen, W. S. Bacot, C. L. Johnson, A. O'Brien, P. Schultze, R. W. Sherman. ***Valhalla.***—E. W. Clarke. ***Walden.***—H. J. Morrison. ***Waterford.***—J. Knickerbacker. ***Watertown.***—F. A. Hinds, T. E. Knowlton, E. W. Sayles. ***West New Brighton.***—C. C. King, H. P. Morrison. ***West Point.***—G. J. Fiebeger, W. P. Wooten. ***Whitehall.***—C. R. Neher.

White Plains.—W. W. Peabody, M. H. Smith, F. W. Watkins, C. E. Wells, F. E. Winsor. ***Yonkers.***—W. H. Baldwin, G. Baum, S. L. Cooper, J. P. Davis, C. L. Spaulding, D. McN. Stauffer.

Associate Members.—***Albany.***—W. H. Adey, A. F. Armstrong, G. M. Braune, H. E. Breed, C. Brown, D. R. Cooper, W. S. Coulter, C. C. Covert, W. R. Davis, H. W. DeGraff, W. T. Dorrance, J. C. Green, W. Greenalch, R. S. Greenman, C. N. Haggart, H. De R. Haight, F. B. Harrington, R. E. Horton, C. Kiehm, F. R. Lanagan, D. R. Lee, A. S. Mirick, J. A. O'Connor, A. H. Perkins, F. N. Sanders, S. M. Savage, H. J. Scheuermann, N. A. Taylor, G. G. Underhill, C. R. Vanneman, A. O. Van Suetendael, N. E. Whitford. ***Amsterdam.***—D. E. Bellows, E. A. Lamb, J. B. Wright. ***Angelica.***—H. S. Wilgus. ***Auburn.***—T. McE. Vickers. ***Baldwinsville.***—D. C. Wedgeworth. ***Binghamton.***—W. Nelson. ***Brewster.***—W. Hauck, C. E. Smith. ***Brooklyn.***—H. J. Alexander, R. S. Armstrong, R. J. Bassett, L. H. Blythe, C. E. Corby, C. R. French, G. S. Frost, J. W. Goodridge, A. J. Griffin, P. Guise, K. O. Guthrie, E. G. Haines, L. T. Haney, C. S. Haynes, E. D. Knap, H. J. Kolb, C. Lobo, A. R. Nichols, F. C. Noble, F. W. Perry, D. T. Pitkethly, J. O. Reynolds, J. C. Riedel, T. B. Shertzer, H. B. Snell, H. C. Sweeney, J. S. Swindells, C. W. Tarr, C. R. Van Buskirk, F. Wilcock, T. L. Wilson, H. W. Woodcock, E. A. Yates. ***Brown Station.***—H. A. Briggs, H. L. Connell, W. J. Gillen, H. S. R. McCurdy, A. A. Northrop, L. F. Searle, F. H. Trow. ***Buffalo.***—R. M. Coomer, D. Cornell, J. W. Eber, G. W. Ellis, W. A. Hazard, J. T. N. Hoyt, C. C. Huestis, G. S. Minniss, N. O. Tiffany, Jr., W. C. Tudbury, T. W. Wilson, W. E. Wilson, F. K. Wing. ***Cambridge.***—F. P. Larmon. ***Canaseraga.***—G. W. Lee. ***Chappaqua.***—D. J. Shaw. ***Cohoes.***—O. Hasbrouck. ***Cold Spring.***—J. G. Peck, A. U. Whitson. ***Cornwall-on-Hudson.***—F. L. Clapp, S. D. Dodge, H. W. Horne, W. E. Swift. ***Cortland.***—C. J. Myers. ***Dobbs Ferry.***—J. J. Walker. ***Elmhurst.***—W. E. Sanford. ***Elmira.***—R. T. Lewis. ***Flushing.***—C. A. D. Bayley, G. S. Hubbell, A. H. Sabin. ***Fort Edward.***—C. A. Curtis. ***Fort Hunter.***—A. E. Steere. ***Fulton.***—T. M. Ripley. ***Garden City.***—C. E. D. Marshall. ***Glen Cove.***—W. H. Bowne. ***Gloversville.***—A. Orr, M. Vrooman. ***Goshen.***—T. C. Marshall. ***Hastings-on-Hudson.***—C. E. Howe. ***Haverstraw.***—C. T. Allison. ***Herkimer.***—E. B. Baker, G. I. Oakley. ***High Falls.***—L. White. ***Hillburn.***—J. B. Strong. ***Ithaca.***—F. A. Barnes, O. M. Leland, E. W. Schoder, F. J. Seery. ***Jamaica.***—E. W. Firth, R. W. How, W. E. Thomas, E. H. Thomes. ***Jordan.***—H. L. Preston. ***Katonah.***—D. Ulrich. ***Kingston.***—W. D. Hubbard, C. G. Reel. ***Little Falls.***—P. H. Dater, O. J. Dempster, A. T. Throop. ***Long Island City.***—C. L. Addison, G. G. Blackmore, A. C. Pflueger, H. Tait, J. Thoma. ***Mamaroneck.***—J. P. Whiskeman. ***Mariner Harbor.***—R. W. Wood. ***Massena.***—G. D. Huntington, R. S. Peotter. ***Medina.***—C. A. Ingersoll, J. E. Jenkins. ***Mohawk.***—C. G. Ranney. ***Montezuma.***—P. J. Cleaver. ***Montgomery.***—F. S. Senior. ***Mt. Kisco.***—F. G. Fowler, C. E. Gregory, E. P. Sanger. ***Mt. Vernon.***—J. F. Fairchild, R. P. Gustin, J. L. Lee, J. W. Mair, C. H. Quimby, Jr. ***New Brighton.***—J. H. Bowditch, A. E. Wenige. ***Newburgh.***—H. LeG.

Hilton, J. N. Hood, N. H. Janvrin. ***New Paltz.***—L. C. Brink, R. H. Keays, S. F. Thomson. ***New Rochelle.***—J. Y. Higginson, L. E. Van Etten. ***New York City.****—A. Adams, J. R. Aikenhead, E. Y. Allen, W. F. Allen, J. Alsberg, R. H. Anderson, W. T. Anderson, R. W. Armstrong, R. F. Arnott, H. B. Atkins, A. Atkinson, T. C. Atwood, W. S. Babcock, P. C. Barney, A. Bartoccini, C. L. Barton, W. R. Bascome, D. E. Baxter, A. R. Baylis, W. N. Beach, F. W. Belknap, B. Berger, J. Berger, A. H. Bieler, C. T. Bissell, G. Blaauw, M. Blanchard, M. Blatt, C. F. Blood, A. P. Boller, Jr., C. P. Bonnett, W. J. Boucher, R. W. Boyd, J. Brady, J. S. Branne, J. I. Brewer, O. L. Brodie, T. B. Brogan, E. S. Brower, A. T. Brown, S. C. Brown, S. P. Brown, W. W. Brush, T. B. Bryson, E. G. Carey, J. P. Carlin, R. E. Carrick, A. E. Carter, H. J. Chambers, H. W. Chambers, P. Chapman, C. Cohen, E. S. Cole, A. A. Conger, W. H. Coverdale, H. Crosby, G. W. Culgin, N. Cummings, S. Cunningham, Jr., W. J. Darrow, J. L. Davis, W. W. DeBerard, J. R. de Gratresse, H. S. Devlin, A. H. Diamant, L. C. Dilks, De F. H. Dixon, J. W. Doty, J. Dougan, P. B. Easterbrooks, L. H. Ehrbar, J. S. Elliott, J. A. Ely, J. M. Evans, W. G. Federlein, L. G. Fenton, F. E. Ferris, G. M. Forrest, M. Foster, T. J. Foster, H. Fougner, A. E. Foyé, J. H. Frazee, M. H. Freeman, E. H. Frisell, W. E. Fuller, J. H. Gandolfo, C. Gartensteig, H. W. Goddard, J. Goodman, L. Goodman, D. B. Goodsell, W. Gray, C. N. Green, F. M. Green, C. Greene, F. S. Greene, N. C. Grover, F. J. Gubelman, A. B. Hager, J. C. Hain, M. W. Hall, A. T. Hardin, H. G. Harrington, A. F. Hartman, J. Hawkesworth, M. D. Hayes, W. A. Heindle, J. J. Herrick, G. Hewitt, J. W. Higgins, J. C. Hilton, B. A. Hodgdon, W. O. Hoffman, P. Holbrook, F. Holmes, E. Holtsmark, S. F. Holtzman, W. J. C. Howalt, F. S. Howell, C. A. Hunt, C. C. Hurlbut, C. Hyatt, J. W. Ijams, R. H. Jacobs, A. Johnson, G. A. Johnson, J. P. Johnston, W. B. Johnstone, H. L. Jones, S. R. Jones, E. F. Jonson, H. D. Jouett, F. P. Kafka, P. A. Kirchner, C. S. Landers, E. P. Lane, T. F. Lange, E. M. Lee, T. H. Letson, C. McK. Lewis, L. H. Lewis, J. Loewenstein, E. McL. Long, E. B. Lovell, G. E. Low, O. Lowinson, G. L. Lucas, J. A. Ludwig, G. A. Lund, G. G. MacCracken, A. A. Macdonald, R. A. MacGregor, G. T. Macnab, P. R. MacNeille, J. B. McCord, L. McHarg, J. W. McMorrow, J. H. Madden, H. B. Magor, A. J. Málukoff, R. J. Mansfield, C. M. Mapes, P. Marquand, E. G. Matheson, W. Meadowcroft, L. L. Melius, O. Merrill, T. Merriman, C. W. Meyers, M. M. Miller, W. G. Moler, C. E. Morrison, R. E. Moss, G. A. H. Mould, L. Muller, J. J. Murphy, J. H. Myers, A. T. Newman, W. A. Nial, C. H. Nichols, G. A. Noska, H. L. Noyes, A. S. Nye, C. J. O'Connor, H. G. Opdycke, H. C. Paddock, J. Paige, G. E. Pellissier, J. Peterson, J. W. Pfau, G. E. J. Pistor, W. J. Plogsted, C. A. Pohl, H. B. Pond, C. A. Poole, A. Potter, C. Potts, A. H. Pratt, P. L. Price, B. B. Priest, A. D. Prince, J. R. Rainbow, H. A. Reid, T. E. Rhoades, F. D. Rhodes, J. H. Richardson, J. P. W. Richmond, D. W. Robbins, F. H. Robbins, A. E. Roberts, E. W. Robinson, G. L. Robinson, H. D. Robinson, H. L. Rogers, A. Rosenthal, C. A. Ruggles,

---

* Includes the Boroughs of Manhattan and the Bronx.

H. P. Rust, M. H. Ryan, H. C. Sanford, R. Schermerhorn, Jr., F. C. Schmitz, F. A. Schrader, P. A. Schuchart, F. W. Schwiers, G. T. Seabury, C. D. Searle, G. G. Shedd, G. Simpson, W. T. Sitt, E. S. Skillin, C. L. Slocum, C. V. Smith, E. F. Smith, E. M. Smith, J. C. Smith, R. B. Smith, T. A. Smith, H. Spencer, R. H. Stearns, F. C. Stehle, A. Stevens, W. F. Stevenson, G. P. Stowitts, J. F. Sullivan, R. Suter, G. Sykes, J. R. Taft, R. C. Taggart, J. G. Tait, E. Talbot, J. G. Theban, C. D. Thomas, G. H. Throop, G. E. Tilt, F. W. Tooker, R. W. Tull, G. D. B. Turner, H. C. Turner, R. D. Upham, M. M. Upson, E. L. Verveer, H. Vier, T. M. Vinton, W. Vredenburgh, Jr., C. L. Wachter, F. C. Waddell, E. L. Walker, E. B. Wardle, H. A. Warren, W. de H. Washington, B. F. Welton, H. R. Wheeler, T. B. Whitney, Jr., T. H. Wiggin, G. S. Wilkins, R. B. Williams, Jr., W. T. Wilson, G. Wood, A. M. Wyman, J. J. Yates, W. H. Yates, H. A. Young. ***Niagara Falls.***—J. W. Darling, L. A. Pettebone, R. V. Rose, O. A. Wait. ***Nyack.***—M. W. Brown. ***Olive Bridge.***—C. U. Stepath. ***Oswego.***—W. L. Lawton, C. H. Snyder. ***Peekskill.***—W. F. Rugg, J. F. Sanborn. ***Plattsburg.***—H. T. Griswold. ***Pleasantville.***—G. G. Honness. ***Port Jefferson.***—A. O. Smith. ***Port Washington.***—R. Johnson. ***Potsdam.***—B. F. Batchelder. ***Poughkeepsie.***—J. T. Collins, R. J. Harding, S. J. Stewart, R. N. Wheeler. ***Richmond Hill.***—C. C. Derby. ***Rochester.***—S. P. Cobb, C. M. Edwards, J. C. Parker, O. M. Severson, W. S. Smith. ***Rome.***—C. L. Bannister, L. A. Burns, W. G. Wildes. ***Roslyn.***—I. H. Kirby. ***Scarsdale.***—F. L. Stearns. ***Schenectady.***—A. W. Burchard, E. J. Pickwick, L. C. Reynolds. ***Schuylerville.***—L. T. Howard. ***Stillwater.***—R. D. Hayes. ***Stone Ridge.***—W. B. Gray. ***Syracuse.***—R. L. Allen, L. D. Brownell, H. N. Cole, F. J. Collins, A. G. Crysler, W. S. Manning, Jr., M. B. Palmer, E. P. Roundey, F. W. Sarr, C. H. Thompson, S. B. Vernon, F. J. Wagner. ***Troy.***—F. Edwards, O. C. Edwards, Jr., W. W. Rousseau. ***Utica.***—M. J. French, C. Lewis, Jr. ***Vailsgate.***—J. L. Hildreth, Jr. ***Valhalla.***—W. F. Smith. ***Vischer Ferry.***—I. S. Matlaw. ***Walden.***—W. W. Stone, A. Thomson, Jr. ***Waterford.***—C. L. McClelland, H. P. Willis. ***Watertown.***—J. P. Burns, P. L. Haas, B. C. Martin, P. H. Winchester. ***Westfield.***—S. E. Fitch. ***West Point.***—G. B. Pillsbury, T. W. Souther. ***West Shokan.***—S. K. Clapp. ***White Plains.***—F. W. Allen, W. F. Jordan, W. B. Reed, Jr., A. W. Tidd. ***Whitesboro.***—W. A. Laller. ***Woodside.***—H. W. Hudson. ***Yonkers.***—C. E. Carpenter, L. Griffith, E. J. Moore.

Associates.—***Albany.***—J. R. Watt. ***Brooklyn.***—A. L. Colsten, J. H. Lundberg, A. R. Piper, J. M. Van Name. ***Buffalo.***—L. J. Bennett, C. W. Bradley, J. MacGregor, A. W. Thorn. ***Flushing.***—A. A. Johnson. ***Ithaca.***—I. P. Church, H. S. Jacoby. ***New York City.****—E. R. Ackerman, J. W. Auchincloss, R. C. C. M. Bernegau, H. Bouton, L. F. Braine, J. M. Bruce, M. D. Chapman, H. R. Codwise, G. N. Cole, A. G. Compton, C. G. Currier, C. de Wyrall, E. J. Farrell, W. C. Fisk, G. H. Frost, A. C. Gildersleeve, J. B. Goldsborough, J. M. Goodell, L. B. Harrison, E. F. Hartmann, J. R. Healy, C. E. Hunt, G. J. Hurst, W. J. Karner, O. B. Keller, W. King, Jr., A. E. Kornfeld, B. H. Leather, A. Liebmann, T. M. May, C.

---

* Includes the Boroughs of Manhattan and the Bronx.

Meriwether, H. C. Meyer, Jr., J. Monks, Jr., A. Moyer, W. C. Oastler, R. G. Packard, Jr., E. B. Phelps, W. A. Polk, L. R. Pomeroy, C. F. Quincy, C. W. Sass, J. R. Shanley, F. H. Smith, F. V. Smith, W. T. Smith, F. Snare, A. Sommer, M. Toch, C. Tomkins, F. E. Townsend, D. A. Usina, J. A. Wells, J. McG. Woodbury, C. G. Young. ***Niagara Falls.***—A. C. Douglass, A. H. G. Hardwicke. ***Tomkins Cove.***—R. I. Odell. ***Troy.***—J. M. Caird. ***Watertown.***—C. E. Dewey. ***Yonkers.***—H. J. Kaltenbach, T. B. McIntire.

Juniors.—***Albany.***—C. F. Breitzke, A. G. Chapman, F. S. Crowell, H. J. Deutschbein, G. P. Graham, T. P. B. Kennedy, W. A. Treadwell, G. E. Willcomb. ***Arlington.***—H. H. Rennell. ***Auburn.***—R. E. Hall. ***Blasdell.***—P. D. Gillham. ***Bridge Hampton.***—W. H. Halsey. ***Brooklyn.***—G. S. Armstrong, Jr., J. R. Baldridge, A. E. Barlow, Jr., T. Belzner, E. S. Closson, A. W. Coombs, W. E. Crane, F. H. Densler, W. T. Derleth, F. J. Felgenhauer, J. S. Frazer, J. C. Gray, R. H. Hammer, J. Schmitt, C. J. Schumann, J. Smith, E. D. Tillson, J. B. Van Vleck, W. W. Wilson. ***Buffalo.***—G. C. Brown, H. Chafetz, J. H. Feigel, W. V. Scott. ***Central Valley.***—R. M. Merriman. ***Cohoes.***—F. E. Reed. ***Cold Spring.***—C. M. Gould, R. W. Greenlaw. ***Cornwall-on-Hudson.***—E. T. King. ***Corona.***—J. D. Richardson. ***Delta.***—J. F. Greathead. ***East Hampton.***—N. N. Tiffany. ***Elmira.***—J. M. Barker, H. A. Brainerd. ***Flushing.***—F. R. Howe. ***Fort Edward.***—H. Shoemaker. ***Freeport.***—A. S. Malcomson. ***Fulton.***—G. C. Andrews. ***Gloversville.***—L. Wachtel. ***Herkimer.***—L. C. Heilbronner. ***High Falls.***—H. M. Hale, J. P. Hogan, H. L. Wittstein. ***Hudson.***—J. C. Peck. ***Ithaca.***—A. P. Mills, V. R. Stirling, C. L. Walker. ***Jamaica.***—G. H. Gifford, A. C. Gregson. ***Katonah.*** T. DeL. Coffin. ***Kingston.***—J. F. Loughran. ***Lockport.***—E. Anderberg. ***Long Island City.***—A. J. Sackett. ***Lyons.***—F. W. Madigan. ***Massena.***—L. A. Whitsit. ***Mechanicsville.***—J. A. Galvin. ***Medina.***—R. H. Merrill. ***Middletown.***—C. H. Smith, M. Stow. ***Mt. Kisco.***—C. W. Banks. ***Mt. Vernon.***—F. M. Gaiger, R. A. Pike. ***New Brighton.***—W. L. Selmer. ***New Paltz.***—A. R. Holbrook, E. H. Hopson, D. W. Howes, H. Leeuw. ***New Rochelle.***—L. P. Bremer, H. S. Loughran. ***New York City.****—H. Abbott, J. S. Adey, R. E. Barrett, F. B. Barshell, L. Bates, Jr., R. C. Becker, F. N. Benedict, O. G. Bennet, Jr., L. S. Benton, H. M. Bergman, J. E. Beswick, C. A. Biggs, C. S. Bilyeu, C. L. Bogert, A. Boniface, J. L. Brennan, J. R. Breuchaud, R. H. Brown, A. E. Budell, G. W. Burpee, D. A. Calhoun, H. H. Cantwell, C. R. Chadwick, W. T. Chevalier, E. C. Church, J. Clausnitzer, F. W. Collins, H. A. Cook, J. W. Cook, H. L. Coyne, C. H. Crooks, N. B. de Forest, C. L. Doe, R. E. Dougherty, G. M. Estabrook, J. K. Finch, H. C. Ford, W. E. Germer, A. L. Gilmore, J. W. Du B. Gould, C. A. Gross, H. P. Hamlin, C. E. Haywood, R. Hitt, B. B. Hodgman, J. J. Hopper, R. H. Howes, D. C. Johnson, P. Jones, M. Ketchum, H. C. Kirkwood, L. Koenig, J. Lowry, Jr., L. H. Lubarsky, H. H. E. Lynn, F. S. MacIlvaine, J. R. McClintock, F. W. McKinney, N. C. McNeil, F. B. Marsh, A. J. Mayell, E. J. Mehren, J. C. Nelson, H. S.

---

* Includes the Boroughs of Manhattan and the Bronx.

Nichol, A. G. Nicolaysen, J. L. Parker, E. Pendlebury, J. P. H. Perry, P. L. Pierce, D. H. Ray, C. S. Reed, C. S. Rindsfoos, H. W. Roberts, V. Roberts, E. F. Robinson, V. R. P. Saxe, E. L. Sayers, M. Shiebler, J. H. Small, Jr., E. G. Smith, W. H. Starr, C. A. A. Steegmuller, A. C. Tozzer, A. O. True, B. F. Vandervoort, J. R. Van Horne, H. L. Van Zile, A. G. Volck, D. C. Waite, H. C. Walton, G. M. Ward, G. L. Wentworth, M. Wormser, A. J. Zabriskie. ***Oswego.***—L. W. Greene. ***Port Washington.***—R. W. Gay. ***Potsdam.***—H. Miller. ***Poughkeepsie.***—E. N. Smith. ***Rhinebeck.***—F. C. Smith. ***Rochester.***—F. J. Howes, K. H. Osborn, W. J. Stewart, C. E. Tirrell, G. C. Wright. ***Rye.***—C. W. Lush. ***Schenectady.***—S. R. Bellows, W. E. Weller. ***Sloatsburg.***—W. S. Fitz-Randolph. ***Stillwater.***—J. C. Gotwals. ***Stone Ridge.***—H. E. Barnes. ***Syracuse.***—D. B. O'Brien. ***Troy.***—J. W. Calder, Le R. W. Clark, E. Littlefield, G. C. See, G. S. Thompson. ***Valhalla.***—E. L. Sprague, Jr. ***Walden.***—D. G. Edwards, W. L. Hanavan, C. Lynde. ***Waterford.***—E. J. Becker. ***Watertown.***—L. B. Cleveland, C. E. Merritt. ***White Plains.***—A. L. Sherman, C. R. Wyckoff, Jr. ***Yonkers.***—J. E. Porter.

Fellows.—***Buffalo.***—J. J. Albright, H. A. Richmond. ***New York City.****—E. D. Adams, C. R. Flint, A. W. Kiddle, H. C. Meyer, J. R. Stanton. ***Rochester.***—C. M. Everest.

NORTH CAROLINA. Total Membership, 19.

Members.—***Beaufort.***—H. T. Paterson. ***Chapel Hill.***—W. Cain. ***Charlotte.***—W. S. Lee, C. A. Mees. ***Clyde.***—W. H. Terrell. ***Rockingham.***—W. A. Leland. ***Wilmington.***—E. I. Brown, E. W. V. C. Lucas. ***Winston.***—J. N. Ambler. ***Winston-Salem.***—J. L. Ludlow.

Associate Members.—***Charlotte.***—J. Firth. ***Durham.***—J. W. Pierce, G. C. White. ***Greensboro.***—J. M. Bandy, E. W. Myers. ***Wilmington.***—C. L. B. Anderson, D. W. Gross.

Juniors.—***Greensboro.***—H. S. Battie. ***Winston-Salem.***—T. J. Wright, Jr.

NORTH DAKOTA. Total Membership, 6.

Members.—***Mandan.***—P. E. Thian.

Associate Members.—***Edgeley.***—K. Alexander, R. L. Alexander. ***University.***—E. F. Chandler. ***Williston.***—G. O. Sanford.

Juniors.—***Cannon Ball.***—W. J. Ryan.

OHIO. Total Membership, 154.

Members.—***Canton.***—L. E. Chapin, E. J. Landor. ***Chardon.***—J. F. Le Baron. ***Cincinnati.***—F. H. Alfred, W. P. Anderson, W. Archer, W. Baldwin, C. C. F. Bent, M. D. Burke, J. A. Fox, J. W. Hill, W. C. Jewett, H. M. Knapp, B. F. Thomas, J. Tuthill, C. A. Wilson. ***Cleveland.***—W. Beahan, F. E. Bissell, W. J. Carter, C. H. Clark, F. A. Coleman, J. W. Frazier, H. Fuller, G. A. Gessner, Jr., B. L. Green, W. O. Henderer, A. J.

---

* Includes the Boroughs of Manhattan and the Bronx.

Himes, R. Hoffmann, C. P. Howard, A. W. Johnston, M. W. Kingsley, F. W. Lepper, F. W. Lovell, J. Millis, W. K. Monroe, J. E. A. Moore, A. Mordecai, B. F. Morse, F. C. Osborn, J. T. Pardee, W. P. Rice, J. Ritchie, S. Rockwell, C. P. Ruple, J. H. Sample, J. W. Seaver, R. E. Sheal, J. C. Spencer, E. M. Sprague, C. Staley, G. H. Tinker, W. J. Watson, C. H. Wright, A. W. Zesiger. ***Columbus.***—E. G. Bradbury, F. L. Chase, F. H. Eno, J. Griggs, C. T. Morris, C. E. Perkins, E. G. Robinson, S. W. Robinson. ***Dayton.***—H. E. Talbott. ***Elyria.***—W. H. Searles. ***Lima.***—F. T. Hepburn. ***Mt. Vernon.***—I. M. Wolverton. ***Sandusky.***—C. A. Judson. ***Springfield.***—G. Thompson. ***Steubenville.***—T. H. Loomis. ***Toledo.***—C. S. Davis, C. L. Gates, G. V. Rhines, H. E. Riggs, M. J. Riggs, W. J. Sherman. ***Washington Court House.***—R. C. Hunt. ***Wellston.***—E. D. Wickes. ***Zanesville.***—J. K. Geddes.

Associate Members.—***Akron.***—L. P. Winterhalter. ***Bellefontaine.***—T. W. Hill. ***Chagrin Falls.***—N. C. Fenkell. ***Chillicothe.***—F. P. Turner. ***Cincinnati.***—J. A. Hiller, H. C. Innes, C. A. Paquette, H. Schneider, C. S. Sheldon, H. W. Vehrenkamp. ***Cleveland.***—H. E. Baldwin, E. W. Cunningham, P. P. Evans, J. E. Grady, A. Gravelle, B. R. Leffler, C. W. Lundoff, F. H. Neff, E. H. Owen, F. A. Pease, S. H. Scharschmidt, R. W. Shelmire, E. B. Thomas, H. S. Williams. ***Columbus.***—L. C. F. Balz, P. Burgess, A. L. Giles, P. Hansen, N. D. Monsarrat. ***Darrowville.***—C. B. Patterson. ***Dayton.***—R. S. King, J. C. Lathrop. ***East Cleveland.***—M. A. Munn. ***East Liverpool.***—F. B. Duis. ***Elyria.***—E. J. Crisp. ***Fairport Harbor.***—G. S. Meek. ***Jefferson.***—J. S. Matson. ***Kent.***—J. A. Donahey. ***Lakewood.***—J. R. Poe. ***Little Hocking.***—C. J. Rannells. ***Mansfield.***—L. A. Keith. ***Martins Ferry.***—J. Blodgett, F. A. Hastings. ***Mt. Vernon.***—C. G. Conley. ***Norwood.***—N. O. Goldsmith. ***Salem.***—T. C. Strawn. ***Sandusky.***—C. M. King, S. B. Newberry. ***Toledo.***—M. C. Bland, J. E. Ferguson, L. M. Gram, C. O. Lasley, P. J. Reich, G. Scott, A. H. Smith. ***Youngstown.***—J. Hunter, B. W. Ranson. ***Zanesville.***—H. E. Frye.

Associates.—***Cincinnati.***—R. Anderson. ***Cleveland.***—E. M. Graves, H. W. King, R. H. Lee, W. P. Palmer, C. B. Stowe. ***Columbus.***—D. W. Brooks, W. R. Copeland. ***Dayton.***—D. H. Morris.

Juniors.—***Ashtabula.***—W. B. Atwood. ***Cincinnati.***—J. E. Barlow, E. A. Gast, O. E. Selby. ***Cleveland.***—O. W. Irwin. ***Hudson.***—L. Ellsworth. ***Mt. Vernon.***—J. R. Brooks. ***Steubenville.***—A. P. Holloway. ***Toledo.***—W. G. Clark.

OKLAHOMA. Total Membership, 14.

Members.—***Lester.***—J. G. Bloom. ***Oklahoma.***—H. V. Hinckley. ***Purcell.***—F. C. Hand.

Associate Members.—***Chandler.***—P. M. Speicher. ***Clinton.***—J. L. O'Hearn. ***Lawton.***—H. J. McDargh. ***Muskogee.***—E. M. Graham, A. B. Kissack. ***Oklahoma.***—C. M. Pritchard. ***Pauls Valley.***—A. C. Polk. ***Stillwater.***—E. E. King. ***Tulsa.***—DeW. C. Fenstermaker.

Juniors.—*Muskogee.*—C. Schultz. ***Oklahoma.*—**C. J. Paterson.

OREGON. Total Membership, 58.

Members.—*Cottage Grove.*—A. B. Wood. ***Klamath Falls.*—**W. W. Patch. ***Medford.*—**W. Gerig, W. J. Roberts. ***Natron.*—**H. I. Randall. ***Nyssa.*—**G. H. Binkley. ***Pokegama.*—**E. T. Abbott. ***Portland.*—**W. G. Brown, D. D. Clarke, F. W. Conn, T. H. Croswell, J. H. Cunningham, F. I. Fuller, W. H. Graves, G. B. Hegardt, D. C. Henny, W. E. Herring, F. Hesse, E. G. Hopson, J. Q. Jamieson, G. W. Lilly, J. B. C. Lockwood, G. C. Mason, J. P. Newell, E. W. Paget, W. R. Phillips, J. S. Polhemus, F. C. Schubert, A. F. Sears, J. F. Stevens, E. A. Taylor, J. T. Whistler.

Associate Members.—*Biggs.*—O. E. Stanley. ***Cascade Locks.*—**C. W. Thompson. ***Cazadero.*—**S. C. Hulse. ***Celilo.*—**F. E. Leefe. ***Cottage Grove.*—**R. E. Griswold. ***Eugene.*—**F. G. Frink. ***Fort Stevens.*—**G. A. Sisson. ***Hermiston.*—**H. D. Newell. ***Portland.*—**W. W. Amburn, J. G. Beach, R. Chase, W. D. Clarke, R. G. Dieck, R. L'A. Donald, E. B. MacNaughton, J. F. Richardson, J. C. Stevens, G. Stubblefield. ***Salem.*—**J. H. Lewis. ***The Dalles.*—**G. A. Kyle.

Juniors.—*Newport.*—R. C. Wygant. ***Portland.*—**S. A. Cobb, T. M. Goodrich, G. Haselton, H. E. Plummer, E. C. Weaver.

PENNSYLVANIA. Total Membership, 472.

Honorary Members.—*Bethlehem.*—J. Fritz. ***Philadelphia.*—**G. W. Melville.

Members.—*Allentown.*—H. F. Bascom, L. J. H. Grossart, C. A. Matcham. ***Altoona.*—**H. Linton. ***Ambridge.*—**R. M. Greene, R. G. Manning. ***Athens.*—**C. Kellogg, C. S. Maurice. ***Bangor.*—**C. Albertson. ***Beaver Falls.*—**C. M. Emmons, C. H. Vaughan, T. S. White. ***Bellevue.*—**W. Martin. ***Braeburn.*—**G. H. Neilson. ***Carbondale.*—**C. L. Rowland. ***Connellsville.*—**J. B. Hogg. ***Cornwall.*—**H. Souder. ***Crafton.*—**J. S. Haring. ***East Downingtown.*—**R. I D. Ashbridge. ***Easton.*—**H. R. Fehr, F. Firmstone, J. McNeal, J. M. Sherrerd. ***Erie.*—**B. E. Briggs, J. Supplee. ***Fort Hunter.*—**D. MacAllister. ***Franklin.*—**F. H. Walker. ***Glenshaw.*—**F. L. Garlinghouse. ***Greensburg.*—**J. B. Bott, De W. P. Pugh. ***Greenville.*—**W. S. McFetridge, H. T. Porter. ***Harrisburg.*—**G. H. Maurice, M. D. Pratt, F. H. Snow. ***Huntingdon.*—**J. M. Africa. ***Johnstown.*—**C. E. Curtis, E. F. Kenney, G. E. Thackray. ***Lancaster.*—**J. B. Rohrer. ***Lansford.*—**B. Snyder, Jr., W. G. Whildin. ***Latrobe.*—**G. Aertsen. ***New Castle.*—**W. G. Price. ***Mauch Chunk.*—**J. Ruddle. ***Meadville.*—**W. A. Doane. ***Philadelphia.*—**F. W. Abbott, W. A. Aiken, C. C. Anthony, W. W. Atterbury, G. P. Baldwin, W. F. Ballinger, L. F. Bellinger, W. F. Biddle, C. S. Bissell, G. P. Bland, A. Bonzano, C. P. Bower, P. F. Brendlinger, H. T. Campion, J. Christie, R. C. Clarkson, F. H. Clement, W. W. Cole, R. L. Crump, J. F. Cullen, G. E. Datesman, E. F. Dawson, R. G. Develin, C. Dillenbeck, F. C. Dunlap, M. W. Easby, W. Easby, Jr., T. N. Ely, S. E. Fairchild, Jr., W. H. Ford, B. Franklin, C. G. Frosell,

W. C. Furber, F. L. Garrison, H. T. Grantham, C. W. Haines, S. Harris, E. P. H. Harrison, J. F. Hasskarl, L. M. Haupt, A. S. Hobby, I. W. Hubbard, R. L. Humphrey, W. Hunter, W. Jones, A. S. Kibbe, P. S. King, F. C. Kunz, B. B. Lathbury, H. W. Latta, J. W. Ledoux, H. R. Leonard, H. F. Lofland, D. J. Lucas, T. C. McCollom, F. B. Maltby, E. Marburg, C. F. Mebus, C. M. Mills, S. P. Mitchell, W. A. Moncure, H. G. Morris, J. F. Murray, W. J. Nicolls, J. C. Patterson, C. P. Perkins, M. R. Pugh, H. H. Quimby, S. Rea, D. Reeves, J. T. Richards, W. B. Riegner, S. H. Rippey, P. Roberts, Jr., P. M. Sax, C. C. Schneider, H. A. Schofield, E. M. Scofield, G. M. Scofield, E. F. Smith, H. C. Smith, J. S. Smith, H. R. Stanford, J. T. Stuart, C. A. Sundstrom, S. M. Swaab, E. B. Temple, J. C. Temple, J. H. Terry, R. Thayer, E. D. Thompson, J. A. Vogleson, J. W. von Leer, T. Voorhees, J. C. Wagner, S. T. Wagner, W. N. Walmsley, W. L. Webb, G. S. Webster, W. R. Webster, J. E. Whitfield, D. H. Whitmer, H. W. Wilson, P. H. Wilson, L. R. Zollinger. ***Phœnixville.***—J. S. Deans. ***Pittsburg.***—L. J. Affelder, J. A. Atwood, H. W. Baker, B. A. Behrend, E. M. Bigelow, J. C. Bland, W. C. Boyd, W. Bradford, N. F. Brown, J. N. Chester, E. W. Crellin, R. A. Cummings, W. C. Cushing, G. S. Davison, P. Didier, E. S. Fickes, E. Gerber, G. A. Gilfillan, E. Godfrey, N. M. Hench, T. H. Johnson, W. M. Judd, H. F. Juengst, W. H. Kennedy, R. Khuen, J. H. Klinck, R. W. Knight, M. Knowles, H. Laub, H. F. Layton, J. K. Lyons, A. B. McGrew, D. W. McNaugher, E. K. Morse, J. C. Neale, C. M. Neeld, J. A. Nelson, J. N. Ostrom, O. R. Pihl, H. S. Prichard, T. Rodd, F. G. Ross, H. B. Rust, W. L. Scaife, A. L. Schultz, G. H. Simpson, C. Strong, E. Swensson, B. H. Taylor, E. B. Taylor, S. A. Taylor, S. La R. Tone, J. W. Walker, E. F. Wendt, G. Westinghouse, F. Wilcox, W. G. Wilkins, P. L. Wölfel, J. Wood, R. B. Woodworth, C. L. Wooldridge. ***Reading.***—E. L. Nuebling, F. S. Stevens. ***Ridgway.***—H. B. Norton. ***Scranton.***—J. Archbald, W. McK. Marple, W. A. May, C. C. Rose, H. H. Shepard. ***South Bethlehem.***—G. H. Blakeley, A. L. Colby, F. P. McKibben, F. E. Schall, C. E. Webster, W. L. Wilson. ***State College.***—E. D. Walker. ***Steelton.***—C. A. Alden, F. W. Cohen, T. Earle, L. E. Johnson, C. H. Mercer, J. V. W. Reynders. ***Sunbury.***—G. Nauman. ***Swarthmore.***—A. Beardsley. ***Swissvale.***—G. R. Harlow. ***Tyrone.***—A. E. Bachert. ***Vintondale.***—S. K. Smith. ***Warren.***—De F. A. Wheelock. ***Wilkes-Barre.***—R. V. A. Norris. ***Wilkinsburg.***—W. C. Hawley. ***Williamsport.***—S. T. Hayt, Jr.

Associate Members.—***Allegheny.***—R. Albree. ***Altoona.***—G. S. Beal, F. Engström. ***Ambridge.***—J. E. Banks, E. B. Butchers, A. L. Lee. ***Ardmore.***—J. R. Potter. ***Bellevue.***—W. H. Hyde. ***Bethlehem.***—S. A. Becker, J. E. Boatrite, J. H. Brillhart, R. E. Neumeyer, J. J. Shonk, H. R. St. A. Walters. ***Bryn Mawr.***—H. S. Farquhar. ***Burnham.***—A. S. Woodle, Jr. ***Camp Hill.***—C. W. Hardt. ***Chambersburg.***—T. J. Brereton. ***Crafton.***—A. C. Beeson. ***Easton.***—W. R. Dunn, W. T. Lyle, J. M. Porter. ***Erie.***—C. Olds. ***Franklin.***—H. W. Claybaugh. ***Greensburg.***—M. Forbes. ***Harrisburg.***—C. I. Bausher, D. L. Diehl, G. W. Ensign, T. Fleming, Jr., F. Gannett, K. C. Grant, W. S. Hanna, W. B. Keim, P. Voorhees.

Hazleton.—R. W. Taylor, Jr. ***Hokendauqua.***—S. R. Thomas. ***Huntingdon.***—F. M. Sawyer. ***Johnstown.***—C. P. Collins, D. T. Corning, V. S. Doebler. ***Lancaster.***—F. H. Shaw, J. H. Wickersham. ***Lewisburg.***—W. Frick. ***Mauch Chunk.***—E. Hazard. ***Mercer.***—G. W. Sykes. ***New Castle.***—T. A. Gilkey. ***Paoli.***—G. R. Sinnickson. ***Philadelphia.***—O. H. Ammann, D. G. Anderson, P. S. Baker, C. W. T. Barker, R. N. Begien, T. F. Boltz, H. C. Booz, E. E. Bratton, E. Clark, C. E. Collins, St. G. H. Cooke, F. R. Davis, J. S. Ely, H. T. Fisher, W. Fisher, O. H. Gentner, Jr., C. F. Gross, W. S. Haldeman, W. S. Harding, C. J. Hogue, E. L. Ingram, W. I. Lex, G. R. Mackenzie, R. Murray, H. V. B. Osbourn, G. F. Pawling, A. B. Perley, H. G. Perring, E. G. Perrot, A. C. Prime, R. F. Proctor, E. J. Rights, M. A. Rue, J. G. Shryock, T. N. Spencer, H. H. Starr, W. L. Stevenson, W. P. Taylor, H. W. Underwood, S. M. Van Loan, C. B. Voynow, A. J. Wills, H. B. Wrigley. ***Phœnixville.***—S. Gowen, C. W. McCornack, N. R. McLure. ***Pittsburg.***—A. C. Ackenheil, A. R. Archer, C. N. Bennett, M. Burden, G. H. Clapp, V. R. Covell, J. L. de Vou, C. G. Dunnells, F. E. Field, E. A. Gibbs, H. A. Greene, G. Gudmundsson, E. D. Harshbarger, A. A. Henderson, N. F. Hopkins, E. N. Hunting, L. L. Jewel, E. S. Johnson, C. S. Lambie, E. G. Lane, J. B. Leeper, T. D. Lynch, W. E. Mott, G. B. Palmer, R. A. Pendergrass, P. W. Price, H. H. Rankin, L. J. Riegler, C. W. Schubert, L. H. Shoemaker, N. S. Sprague, J. L. Stuart, D. Y. Swaty, G. L. Taylor, H. R. Thayer, L. D. Tracy, G. C. Urquhart, W. Whited, W. D. Wiggins, T. J. Wilkerson, C. S. Williamson, F. W. Witherell, G. R. Wood. ***Pottsville.***—T. M. Lavelle. ***Reading.***—E. B. Ulrich. ***Republic.***—W. O. White. ***St. Marys.***—W. R. Craig. ***Saltsburg.***—A. Smith. ***Schuylkill Haven.***—G. W. Butz. ***Scranton.***—R. D. Richardson. ***South Bethlehem.***—L. De V. Conkling. ***State College.***—P. B. Breneman, R. I. Webber. ***Steelton.***—S. W. Bradshaw, C. B. Ely, J. H. Myers. ***Susquehanna.***—E. I. Bowen. ***Swissvale.***—J. P. J. Williams. ***Titusville.***—W. A. Jones. ***Washington.***—O. K. Taylor, Jr. ***Wilkes-Barre.***—C. Enzian, H. S. Smith. ***Wilkinsburg.***—L. E. Lannan. ***York.***—T. T. Heiges.

Associates.—***Allentown.***—C. M. Saeger. ***Chester.***—S. G. Comfort. ***Erie.***—W. C. Olds. ***Overbrook.***—S. Bent. ***Philadelphia.***—A. H. Bromley, Jr., J. G. Brown, G. Burnham, Jr., L. V. Clark, A. J. County, H. B. Green, W. G. Hartranft, R. W. Lesley, J. B. Lober, J. P. A. Maignen, A. G. Patton, J. C. Trautwine, Jr. ***Pittsburg.***—J. A. Huston, C. C. Smith. ***Steelton.***—G. W. Parsons.

Juniors.—***Ambridge.***—H. M. Hoisington, K. W. Lemcke. ***Beaver.***—W. R. Hughes, Jr. ***Bethlehem.***—F. R. Schmid, A. J. Warlow. ***Carbondale.***—A. B. Cole. ***Carlisle.***—C. A. Bingham. ***Greenville.***—F. R. S. Layng. ***Harrisburg.***—R. J. Colgan, R. M. Riegel. ***Hazleton.***—D. H. Brown. ***Huntingdon.***—C. R. Simpson. ***Kittanning.***—H. H. Garrigues. ***Lancaster.***—A. H. Kohn. ***McKeesport.***—J. B. Sweeney. ***Oakmont.***—J. T. Libbey. ***Philadelphia.***—E. W. Banker, H. E. Bushnell, H. McM. Dibert, L. T. Emory, L. R. Ferguson, C. H. Field, H. C. Gardner, T. O.

Gilland, I. S. Grindrod, W. H. McCandliss, L. E. Perry, C. B. Suttl A. L. Terry, Jr., S. D. Watkins. ***Phœnixville.***—R. S. Foulds. ***Pittsburg.***—F. Burroughs, F. Y. Dorrance, F. L. Metzger, C. F. Peck, J. M. T Rice, J. K. Scott, O. J. Swensson, G. J. Walker, C. L. Wilcox. ***Pottsville*** —E. G. King. ***Rankin.***—H. G. Gearhart, N. E. Waddell. ***Reading.***— E. B. Hedden. ***Steelton.***—C. Miller. ***Wilkes-Barre.***—R. Hand, G. C Jacobosky, F. C. Wintermute. ***Wilkinsburg.***—C. L. Fox.

Fellows.—*Philadelphia.*—E. W. Clark, B. N. Farren.

RHODE ISLAND. Total Membership, 48.

Members.—*Arlington.*—H. N. Francis. ***Narragansett Pier.***—W. Kent ***Newport.***—J. P. Cotton, W. H. Lawton, J. W. G. Walker. ***Pawtucket*** —G. A. Carpenter. ***Providence.***—A. H. Blanchard, J. S. Browne, W. D Bullock, C. F. Chase, O. F. Clapp, J. V. Dart, E. P. Dawley, J. R. Freeman, S. M. Gray, J. E. Hill, G. H. Leland, E. W. Ross, O. P. Sarle E. W. Shedd, J. H. Shedd, H. E. Sherman, W. H. G. Temple, E. B Weston, I. S. Wood. ***Woonsocket.***—J. W. Ellis.

Associate Members.—*Portsmouth.*—L. Tallman. ***Providence.***—W. L. Anthony, H. W. Ballou, N. D. Benson, H. B. Drowne, G. F. Hosmer, P. S Perkins, W. B. Wood. ***Westerly.***—T. McKenzie.

Juniors.—*Bridgeton.*—E. J. Potter. ***Newport.***—A. M. Chace, S. H. Noyes ***Pawtucket.***—H. F. Esten. ***Providence.***—M. H. S. Affleck, H. B. Edmundson, F. I. Greene, C. M. Hathaway, H. E. Miller, I. W. Patterson L. H. Peabody, Jr., O. W. Rackle, H. A. Sweetland.

SOUTH CAROLINA. Total Membership, 16.

Members.—*Charleston.*—J. P. Allen. ***Columbia.***—G. E. Shand, C. C. Wilson ***Georgetown.***—R. Whitford. ***Greenville.***—P. M. Feltham, J. E. Sirrine ***Spartanburg.***—W. B. W. Howe.

Associate Members.—*Blacksburg.*—H. K. Hood. ***Charleston.***—E. M Adams, J. H. Dingle, E. R. Gayler. ***Greenville.***—W. D. Dent, H. T Poe, Jr. ***Greenwood.***—T. W. Cothran.

Associates.—*Charleston.*—J. M. Diven.

Juniors.—*Abbeville.*—W. L. Hemphill.

SOUTH DAKOTA. Total Membership, 9.

Members.—*Pierre.*—S. H. Lea. ***Sioux Falls.***—C. C. Witt.

Associate Members.—*Brookings.*—H. M. Derr. ***Lead.***—B. C. Yates ***Orman.***—O. T. Reedy. ***Vermilion.***—A. B. McDaniel.

Juniors.—*Aberdeen.*—R. B. Easton. ***Orman.***—F. C. Magruder. ***Watertown*** —J. C. Carpenter.

TENNESSEE. Total Membership, 46.

Members.—***Chattanooga.***—H. S. Bosler, J. A. Fairleigh, W. D. Jenkins. ***Columbia.***—W. P. Watson. ***Etowah.***—G. K. McCormick. ***Guild.***—G. F. Rowell. ***Jackson.***—H. P. Farrar. ***Johnson City.***—M. J. Caples. ***Knoxville.***—W. W. Carson, C. B. Wilson. ***Memphis.***—E. H. Bowser, A. B. Diehr, W. M. Gardner, W. W. Hayden, F. H. Hilliard, L. Y. Kerr, H. N. Pharr, M. L. Walker. ***Nashville.***—A. J. Dyer, W. F. Foster, H. M. Gould, E. L. Harman, W. W. Harts, H. M. Jones, E. C. Lewis, C. A. Locke, H. McDonald, W. N. McDonald, T. H. Tutwiler, J. S. Walker.

Associate Members.—***Chattanooga.***—E. E. Betts, W. H. Converse, D. H. Wood. ***Johnson City.***—J. R. Fain, J. E. Shepardson. ***Knoxville.***—S. D. Newton. ***Memphis.***—J. W. Davenport, L. R. Gifford, J. H. Haylow, J. A. Omberg, Jr. ***Nashville.***—G. Jackson. ***Sewanee.***—B. LeF. Coulson.

Juniors.—***Chattanooga.***—H. B. W. Howie. ***Memphis.***—H. N. Howe, E. Neuhardt. ***Nashville.***—W. P. Stewart.

TEXAS. Total Membership, 75.

Members.—***Altura.***—W. G. Russell. ***Austin.***—T. U. Taylor. ***Beaumont.***—C. L. Scherer. ***College Station.***—J. C. Nagle. ***Corsicana.***—H. G. Johnston. ***Dallas.***—H. E. Arthur, C. H. Chamberlin, O. H. Lang, O. Shanks, R. C. Smead, B. S. Wathen. ***El Paso.***—J. L. Campbell, W. W. Follett, W. M. Reed, F. H. Todd. ***Fort Worth.***—J. B. Hawley, W. B. King. ***Galveston.***—E. M. Hartrick, G. P. Howell, W. P. Parker, L. W. Stubbs. ***Houston.***—E. B. Cushing, J. M. Howe, H. F. Jonas, E. J. Nichols. ***San Antonio.***—R. H. Gresham. ***Terrell.***—L. W. Wells. ***Tyler.***—M. L. Lynch.

Associate Members.—***Amarillo.***—G. W. Harris. ***Austin.***—E. C. H. Bantel, R. D. Parker. ***Beaumont.***—A. C. Love, W. G. Massenburg. ***Dallas.***—F. H. Lancashire, A. E. Waldron. ***Eagle Lake.***—T. L. Smith, Jr. ***El Paso.***—T. P. Moorehead, O. S. Osborn, H. A. Patch. ***Fort Worth.***—B. G. Leake, E. C. Woodward. ***Galveston.***—G. N. Copley, R. C. Hardman, J. C. Oakes. ***Houston.***—W. M. Archibald, H. E. Elrod, T. L. Fountain, D. F. Horton. T. E. Jewett, J. G. Johnston, A. V. Kellogg, E. G. Maclay, C. A. Thanheiser. ***Midland.***—D. M. White. ***Port Arthur.***—L. T. Gaylord. ***San Juan.***—F. M. Hough. ***Victoria.***—L. A. Gueringer. ***Wichita Falls.***—R. A. Thompson.

Juniors.—***Austin.***—S. P. Finch. ***Baird.***—W. J. Powell. ***Corpus Christi.***—C. F. K M. von Blücher. ***Dallas.***—L. W. Anderson. ***Eagle Lake.***—A. P. Rollins. ***El Paso.***—C. P. Chester. ***Ennis.***—D. E. Pendleton. ***Fort Worth.***—A. C. Kellersberger. ***Galveston.***—N. T. Blackburn, C. M. Davis. ***Houston.***—J. Cochran, C. J. Howard, J. L. Jacobs, R. L. Ramsdell, P. B. Tallman. ***Lockhart.***—F. M. Thomson. ***Ovalo.***—J. M. Warner.

UTAH. Total Membership, 26.

Members.—***Ogden.***—A. F. Parker. ***Provo.***—P. N. Nunn. ***Salt Lake City.***—W. Ashton, G. M. Bacon, F. E. Baxter, A. F. Doremus, F. C. French, R. C. Gemmell, L. C. Kelsey, R. B. Ketchum, M. M. Murtaugh.

Associate Members.—***Ogden.***—L. B. Spencer. ***Provo.***—V. Y. Davoud, J. L. Lytel. ***Salt Lake City.***—C. F. Brown, R. K. Brown, M. S. Darrow, J. Duder, R. P. Hovey, H. S. Kleinschmidt, E. C. LaRue, R. R. Lyman, H. W. Sheley, P. L. Williams, Jr.

Juniors.—***Bingham Canyon.***—F. Miller. ***Provo.***—C. S. Jarvis.

VERMONT. Total Membership, 7.

Members.—***Burlington.***—F. O. Sinclair. ***Hartland Four Corners.***—H. Harding. ***Rutland.***—J. C. Irwin. ***St. Johnsbury.***—D. Williams.

Associate Members.—***Burlington.***—J. W. Elliott, G. S. Miller. ***Northfield.***—A. E. Winslow.

VIRGINIA. Total Membership, 67.

Members.—***Blacksburg.***—L. S. Randolph. ***Dante.***—W. D. Tyler. ***Harrisonburg.***—N. W. Davis. ***Houston.***—H. C. Derrick. ***Leesburg.***—H. H. Trundle, C. O. Vandevanter. ***Lexington.***—D. C. Humphreys. ***Lynchburg.***—C. G. Williams. ***Newport News.***—W. A. Post. ***Norfolk.***—S. Carter, H. Fernstrom, F. F. Harrington, L. E. Lyon, F. L. Nicholson, E. B. Noyes, M. M. Patrick. ***Petersburg.***—J. W. Hays. ***Portsmouth.***—E. A. Frink. ***Richmond.***—D. Axtell, H. Frazier, E. T. D. Myers, Jr., H. Pierce, F. W. Scarborough, S. H. Yonge. ***Rio.***—C. M. Bolton. ***Roanoke.***—C. S. Churchill, W. W. Coe, J. E. Crawford, G. A. Tretter, C. C. Wentworth. ***Waynesboro.***—W. A. Pratt. ***Wenonda.***—J. A. Hall. ***Zion.***—G. H. Browne.

Associate Members.—***Abingdon.***—E. F. Deacon. ***Alexandria.***—E. C. Dunn. ***Fordwick.***—R. J. Hawn. ***Kerrs Creek.***—W. C. Hattan. ***Lynchburg.***—C. L. DeMott, G. H. Gilbert, C. B. Scott, H. L. Shaner, P. B. Winfree. ***Newport News.***—A. L. Hopkins. ***Norfolk.***—A. C. Freeman, Jr., J. H. Randolph, Jr., R. H. Rice, C. D. Thurber. ***Portsmouth.***—V. E. McBee, Jr. ***Richmond.***—A. C. Copland, O. L. Grover, F. H. Haskell. ***Roanoke.***—W. B. Bates, P. A. Blackwell, E. Gray, Jr., S. S. Storer, W. P. Wiltsee. ***Salem.***—W. Watson. ***The Plains.***—J. R. Downman. ***Winchester.***—W. M. Myers.

Associates.—***Blackstone.***—E. B. Fishburne, Jr. ***Richmond.***—G. O. Tenney.

Juniors.—***Lynchburg.***—E. E. Barnard. ***Norfolk.***—H. V. Joslin. ***Portsmouth.***—L. Chevalier, W. D. Faucette. ***Roanoke.***—R. L. Lindsay. ***Yorktown.***—W. D. Cater.

WASHINGTON. Total Membership, 105.

Members.—*Bellingham.*—J. J. Donovan. ***Bremerton.*—**F. W. D. Holbrook, C. W. Parks, P. L. Reed. ***Edmonds.*—**M. Chase. ***Ellensburg.*—**E. H. Baldwin. ***Fort Casey.*—**S. D. Mason. ***Mt. Vernon.*—**C. G. Darrach. ***North Yakima.*—**E. M. Kenly, T. A. Noble. ***Seattle.*—**J. P. Badenhausen, H. M. Chittenden, J. M. Clapp, B. D. Dean, A. S. Downey, C. E. Fowler, J. L. Hall, J. J. Harding, S. H. Hedges, E. B. Hussey, J. Jacobs, C. W. Kutz, E. J. McCaustland, D. W. McMorris, A. W. Münster, R. H. Ober, H. K. Owens, E. J. Pearson, A. O. Powell, R. H. Thomson, W. C. Weeks. ***Spokane.*—**C. Andersen, O. S. Bowen, U. B. Hough, A. McC. Lupfer, S. A. McCoy, P. Mogensen, W. E. Moore, F. L. Pitman, J. C. Ralston, B. C. Riblet, F. McC. Sylvester. ***Sunnyside.*—**E. McCulloh, I. Watson. ***Tacoma.*—**B. L. Crosby, H. A. Hall.

Associate Members.—*Blaine.*—E. B. Day. ***Centralia.*—**C. De La P. Atterbury. ***Chehalis.*—**L. S. Oakes, P. A. G. Tilmont. ***Conconully.*—**O. Laurgaard. ***East Seattle.*—**S. B. Phillips. ***Ellensburg.*—**L. J. Charles. ***Enumclaw.*—**H. H. Wolff. ***La Conner.*—**A. W. Sargent. ***Leavenworth.*—**A. H. Sylvester. ***North Yakima.*—**J. S. Conway. ***Olympia.*—**H. L. Gray. ***Seattle.*—**H. J. M. Baker, M. H. Brinkley, H. D. Bruning, B. E. Corlett, C. B. Lamont, E. C. Macy, C. C. More, S. Murray, A. T. Nelson, C. H. Reeves, H. R. Robbins, J. H. Shortt. ***Spokane.*—**A. D. Butler, D. Hays, M. Macartney, W. H. Phillips, G. R. Ramsey, D. H. Sawyer, G. L. Sawyer. ***Sunnyside.*—**E. A. Moritz. ***Tacoma.*—**R. H. Corey, C. L. Creelman, J. E. Moody, S. Sims. ***Vancouver.*—**E. J. Dent. ***Wapato.*—**J. H. Best. ***Wenatchee.*—**J. W. Sussex, C. C. Ward.

Associates.—*Seattle.*—A. H. Fuller.

Juniors.—*Bremerton.*—H. F. Scholtz, H. E. Squire. ***Fort Ward.*—**P. H. Ottosen. ***Hadlock.*—**J. C. F. Shafer. ***North Yakima.*—**I. P. Jones. ***Olympia.*—**H. F. Forsyth, J. C. Rathbun. ***Pullman.*—**W. C. Willard. ***Seattle.*—**C. D. Ashbrook, E. E. Erdmann, S. B. Hill, W. Lewis, F. M. Smith. ***Spokane.*—**J. W. Cunningham, C. H. Jabelonsky, W. Le R. Malony, R. J. Schmid. ***Warden.*—**W. W. Mitchell.

WEST VIRGINIA. Total Membership, 31.

Members.—*Berkeley Springs.*—B. S. Randolph. ***Charleston.*—**S. P. Baird, A. M. Scott. ***Clarksburg.*—**D. D. Britt, T. M. Jackson. ***Elkins.*—**J. F. Healy. ***Gary.*—**H. N. Eavenson. ***New Cumberland.*—**C. E. Grafton. ***Parkersburg.*—**S. D. Brady, W. McL. Hall. ***Welch.*—**J. A. Davenport. ***Wellsburg.*—**F. D. Holbrook.

Associate Members.—*Bluefield.*—J. L. Morrison. ***Charleston.*—**R. P. Black. ***Clarksburg.*—**G. M. Bassell. ***Fraziers Bottom.*—**C. E. McCoy. ***Gary.*—**J. Taylor, Jr. ***Martinsburg.*—**J. F. Rodenbough. ***Morgantown.*—**W. H. Boughton. ***Parkersburg.*—**J. P. Horstman, J. M. Jackson. ***Wheeling.*—**F. W. Altstaetter, R. Hazlett, J. A. McDonough.

Associates.—***Charleston.***—W. D. Sell. ***Morgantown.***—J. V. Howe.

Juniors.—***Morgantown.***—R. L. Reimann-Hansen. ***Princeton.***—H. E. Hines ***Wheeling.***—L. O. Barker, Jr., P. F. Rossell, J. Shema.

WISCONSIN. Total Membership, 37.

Members.—***La Crosse.***—W. A. Thompson. ***Madison.***—D. W. Mead, W. D Pence. ***Milwaukee.***—G. H. Benzenberg, W. F. Carr, R. E. Newton, C. J Poetsch, W. J. Sando, F. Weinhagen. ***South Milwaukee.***—S. L. G Knox. ***Superior.***—M. W. Lewis.

Associate Members.—***De Pere.***—G. P. Hawley. ***Madison.***—G. J. Davis, Jr. C. V. Seastone, L. S. Smith, C. B. Stewart, F. E. Turneaure. ***Mayville***—A. F. Plock. ***Milwaukee.***—A. C. Bell, L. E. Bogen, J. C. Davis, J. C Fruit, J. F. Jackson, L. D. Williams. ***Neillsville.***—L. R. Balch. ***South Milwaukee.***—W. M. Rosewater. ***Whitewater.***—E. C. Bebb.

Associates.—***North Milwaukee.***—T. R. Brown.

Juniors.—***Madison.***—R. M. Feustel, L. P. Jerrard, C. R. Weidner. ***Milwaukee.***—O. B. Carlisle, S. A. Greeley, G. E. Kahn, G. C. Newton, W. L Rowe.

Fellows.—***Milwaukee.***—S. M. Green.

WYOMING. Total Membership, 15.

Members.—***Cheyenne.***—C. T. Johnston, H. B. Patten. ***Cody.***—D. W. Cole ***Evanston.***—W. Newbrough. ***Laramie.***—W. R. Smith, R. D. Stewart ***Sheridan.***—E. Gillette.

Associate Members.—***Cody.***—R. C. Soper, L. R. Stockman. ***Lander.***—M. DeT. Kelley. ***Pathfinder.***—L. V. N. Branch. ***Sheridan.***—E. L Clarke. ***Wheatland.***—J. C. Hadsall. ***Wiley.***—G. W. Zorn.

Juniors.—***Green River.***—O. C. Lisman.

CENTRAL AMERICA.

COSTA RICA. Total Membership, 5.

Members.—***Guapiles.***—P. W. Chamberlain. ***San José.***—W. H. Cushman, H. Hardy, L. Matamoros.

Juniors.—***Limon.***—N. Benedict.

HONDURAS. Total Membership, 1.

Associate Members.—***Ceiba.***—D. J. Linard.

NICARAGUA. Total Membership, 1.

Members.—***Managua.***—J. C. Wiest.

PANAMA. Total Membership, 34.

Members.—***Balboa.***—W. T. Blunt. ***Corozal.***—J. M. G. Watt, S. B. Williamson. ***Culebra.***—H. Goldmark, H. F. Hodges, T. E. L. Lipsey, C. M. Saville, W. L. Sibert. ***Empire.***—L. K. Rourke, A. S. Zinn. ***Gatun.***—C. Harding. ***Panama.***—J. G. Holcombe.

Associate Members.—***Bohio.***—R. W. Hebard. ***Corozal.***—H. O. Cole, A. R. James, W. Rowland. ***Cristobal.***—C. Nixon, F. C. Stanton. ***Culebra.***—L. D. Cornish, M. Elliott, T. B. Mönniche, H. H. Rousseau, E. C. Sherman, H. F. Tucker, R. R. Wiggins. ***Gatun.***—C. P. Fortney, G. M. Wells.

Juniors.—***Ancon.***—O. E. Malsbury. ***Bocas del Toro.***—A. G. Robertson. ***Corozal.***—H. W. Bluhm. ***Cristobal.***—E. B. Karnopp. ***Gatun.***—A. R. Brown. ***La Boca.***—W. J. Spalding. ***Las Cascadas.***—W. D. Stanton.

SOUTH AMERICA.

ARGENTINE REPUBLIC. Total Membership, 10.

Members.—***Bahia Blanca.***—C. Anthony, Jr. ***Buenos Aires.***—W. L. Brown, A. B. Lea, C. Wauters. ***Colonia Alvear.***—G. A. Lange. ***Córdoba.***—C. C. Lewis.

Associate Members.—***Buenos Aires.***—A. A. Agramonte, P. Smith. ***Mendoza.***—J. J. Corti.

Juniors.—***San Carlos.***—H. L. Miller.

BOLIVIA. Total Membership, 4.

Members.—***La Paz.***—J. Pierce-Hope.

Associate Members.—***Oruro.***—W. L. Gibson.

Juniors.—***Oruro.***—C. A. Bock, J. H. Frazer.

BRAZIL. Total Membership, 17.

Members.—***Bahia.***—M. de T. e Argollo. ***Manãos.***—P. H. Ashmead, J. Y. Bayliss, H. F. Dose. ***Rio de Janeiro.***—J. A. dos Santos, W. G. McConnel, H. C. Ripley. ***Rio Grande.***—E. L. Corthell. ***Santos.***—W. Huggins. ***São Paulo.***—V. da Silva Freire.

Associate Members.—***Bello Horizonte.***—L. Baeta-Neves. ***Manãos.***—W. K. Runyon, W. D. Sample. ***Rio de Janeiro.***—J. Pires do Rio, T. P. Stevenson, Jr.

Juniors.—***Manaos.***—H. L. Eames, J. R. Wilbanks.

CHILI. Total Membership, 4.

Members.—***Santiago.***—R. W. Hornsby, J. Tonkin Thomas. ***Valparaiso.***– E. B. Budge.

Associate Members.—***Concepcion.***—J. Du Bois.

COLOMBIA. Total Membership, 5.

Members.—***Barranquilla.***—C. P. Yeatman. ***Bogota.***—G. A. Ritchie.

Associate Members.—***Cali.***—H. J. Eder, R. B. Manter. ***Girardot.***—A. de l Torre.

ECUADOR. Total Membership, 1.

Associate Members.—***Ambato.***—W. G. Fox.

PERU. Total Membership, 9.

Members.—***Arequipa.***—T. A. Corry. ***Lima.***—A. B. Bentzon.

Associate Members.—***Arequipa.***—J. A. Arce. ***Lima.***—R. Ferradas, W. T Turner. ***La Oroya.***—J. H. Burgoyne, Jr. ***Trujillo.***—C. W. Sutton.

Juniors.—***Lima.***—F. Carbajal, P. E. Tillit.

URUGUAY. Total Membership, 1.

Associate Members.—***Montevideo.***—V. B. Sudriers.

WEST INDIA ISLANDS.

CUBA. Total Membership, 42.

Members.—***Camagüey.***—S. F. Shaw. ***Guantanamo.***—C. L. Carpenter, A. V Sims. ***Havana.***—T. T. Allard, M. A. Coroalles, F. L. Getman, D. E McComb, E. W. McCormack, J. A. McNicol, M. A. Smith, G. B. Strickler. ***Matanzas.***—Y. Polledo. ***Santiago de Cuba.***—E. J. Chibas.

Associate Members.—***Camagüey.***—J. M. Farrin. ***Felton.***—A. C. Reed. ***Firmeza.***—E. M. Holmes, N. P. Turner. ***Havana.***—J. M. Babé, C. C. FitzGerald, T. Frasquieri y Regueifero, T. L. Huston, H. E. Hyde, C. E. Martinez y Reugifo, A. E. Mesa, F. A. Snyder, J. Stockton, C. del Valle Zeno, J. R. Villalon. ***Manzanillo.***—F. E. Estes. ***Palma Soriano.*** F. L. M. Tönnesen. ***Sagua la Grande.***—G. P. Morrill. ***Santiago de Cuba.***—S. A. Barratt, G. W. Pfeiffer.

Juniors.—***Guantanamo.***—G. C. Peterson. ***Havana.***—R. S. Giquel, E. P. Hamilton, J. D. Montero, P. A. Suarez y Cordoves, M. Villa, R. S. Webster. ***Matanzas.***—G. A. Dubois. ***Santa Clara.***—G. G. Fischer.

DOMINICA. Total Membership, 1.

Associate Members.—***Roseau.***—A. H. Green.

JAMAICA. Total Membership, 2.

Associate Members.—***Kingston.***—J. H. Dodd. ***Richmond.***—J. M. Fletcher.

PORTO RICO. Total Membership, 10.

Members.—***Guayama.***—B. M. Hall. ***Ponce.***—M. V. Domenech, V. A. Harris. ***San Juan.***—J. A. Canals.

Associate Members.—***Guayama.***—B. S. Drane, J. M. Giles, F. Pace. ***San Juan.***—L. J. Proctor.

Juniors.—***Guayama.***—W. E. Hall, O. Y. Leonard.

SANTO DOMINGO. Total Membership, 5

Members.—***Santo Domingo.***—W. H. Balch.

Associate Members.—***Azua.***—S. A. Miller. ***Santo Domingo.***—H. A. Harris, J. L. Mann.

Juniors.—***Santo Domingo.***—L. M. Huntington.

EUROPE.

AUSTRIA. Total Membership, 3.

Members.—***Vienna.***—C. Redlich, F. E. von Emperger, E. A. Ziffer.

DENMARK. Total Membership, 2.

Members.—***Charlottenlund.***—M. I. Nyeboe.

Associate Members.—***Aarhus.***—H. T. Forchhammer.

FRANCE. Total Membership, 5.

Corresponding Members.—***Paris.***—E. Pontzen.

Members.—***Nice.***—J. H. Johnston. ***Paris.***—E. Budge, J. H. Pope, P. A. Seurot.

GERMANY. Total Membership, 3.

Corresponding Members.—***Hamburg.***—C. O. Gleim.

Members.—***Deutsch-Eylau.***—R. Bassel.

Associate Members.—***Berlin.***—A. Jordahl.

GREAT BRITAIN. **Total Membership, 44.**

Honorary Members.—***London, Eng.***—D. Fox, W. H. White.

Members.—***Birmingham, Eng.***—H. P. Raikes. ***Carlisle, Eng.***—G. J. Bell. ***Edinburgh, Scotland.***—J. H. Cunningham. ***Freshford, Eng.***—E. H. Stone. ***Goodwyns, Eng.***—E. H. Hurry. ***Hitchin, Eng.***—D. Simson. ***Ightham, Eng.***—J. R. Bell. ***London, Eng.***—R. M. Arango, R. Ballard, R. T. Bayliss, W. H. Booth, J. R. Chapman, A. N. Connett, A. G. Glasgow, J. W. Grimshaw, K. P. Hawksley, R. Hawxhurst, Jr., H. C. Hoover, J. W. Jacomb-Hood, Z. E. Knapp, J. A. McDonald, C. F. Marsh, O. J. Marstrand, H. S. Maxim, E. W. Moir, J. P. O'Donnell, J. Orange, F. Palmer, J. E. Selander, M. E. Yeatman. ***Manchester, Eng.***—W. H. Hunter. ***Middlesbrough, Eng.***—J. E. Swanker. ***Newcastle-upon-Tyne, Eng.***—J. M. Moncrieff.

Associate Members.—***Ashford, Eng.***—P. à M. Parker. ***Glasgow, Scotland.***—A. Hunter. ***London, Eng.***—J. Abella, C. D. Drew. ***Tiverton, Eng.***—E. Brook-Fox. ***Widnes, Eng.***—P. M. Pritchard.

Juniors.—***Glasgow, Scotland.***—R. M. Smith. ***Hull, Eng.***—E. G. Walker. ***London, Eng.***—R. Tappan.

ITALY. **Total Membership, 2.**

Members.—***Alassio.***—H. S. Haines. ***Rome.***—L. Luiggi.

NETHERLANDS. **Total Membership, 2.**

Members.—***Amsterdam.***—R. P. J. Tutein-Nolthenius.

Juniors.—***Utrecht.***—J. A. de Lint.

NORWAY. **Total Membership, 3.**

Associate Members.—***Bergen.***—A. Gundersen. ***Christiania.***—H. T. Opsahl, G. H. Vedeler.

RUSSIA. **Total Membership, 7.**

Members.—***Novorossiisk.***—T. S. Shmeleff. ***St. Petersburg.***—S. de Kareischa, S. P. Maximoff, V. E. Timonoff.

Associate Members.—***Archangel.***—U. Taubenheim.

Juniors.—***Suwalki.***—A. I. Wolkowyski. ***Warsaw.***—A. Mischke.

SPAIN. **Total Membership, 1.**

Members.—***Barcelona.***—J. Tintorer y Giberga.

SWEDEN. Total Membership, 3.

Associate Members.—***Göteborg.***—J. K. Selmer. ***Malmo.***—G. V. Dieden. ***Stockholm.***—I. Kreuger.

SWITZERLAND. Total Membership, 2.

Members.—***Lausanne.***—J. M. Howells. ***Zurich.***—K. E. Hilgard.

AFRICA.

Total Membership, 9.

Members.—***Buiko, German East Africa.***—A. T. Kroeber. ***Bulawayo, Rhodesia.***—C. Corner. ***Grootfontein, German Southwest Africa.***—T. Tönnesen.

Associate Members.—***Bethlehem, Orange River Colony.***—W. M. Homan. ***Bloemfontein, Orange River Colony.***—C. J. Armstrong. ***Capetown, Cape Colony.***—W. B. Leane. ***Germiston, Transvaal.***—A. W. Stockett. ***Johannesburg, Transvaal.***—S. F. Stokes. ***Queenstown, Cape Colony.***—J. T. B. Gellatly.

ASIA.

CHINA. Total Membership, 17.

Members.—***Canton.***—K. Y. Kwong. ***Nanking.***—T. W. T. Tuckey. ***Peking.***—C. D. Jameson. ***Tientsin.***—E. G. Adams, Jr. ***Wuhu.***—E. J. Müller. ***Yunnanfu.***—W. S. Dawley.

Associate Members.—***Canton.***—J. S. Goodell. ***Dairen.***—T. Shima. ***Foo Chow.***—E. F. Black. ***Hankow.***—H. E. Baker. ***Ichang.***—T. C. Yen. ***Nanking.***—T. J. Bourne, F. E. Hermanns. ***Shanghai.***—T. A. Ross, ***Tientsin.***—M. H. Peck, J. C. Vliegenthart.

Juniors.—***Weihsien.***—H. E. Chandler.

COREA. Total Membership, 1.

Members.—***Chemulpo.***—T. Endo.

INDIA. Total Membership, 7.

Members.—***Anantapoor.***—N. P. Hara Aiyar. ***Bengal.***—J. Smith. ***Madras.***—F. J. E. Spring. ***Lahore.***—C. Lall. ***Trichur.***—G. E. Browning.

Associate Members.—***Calcutta.***—R. H. Sears. ***Fort Bombay.***—G. F. F. Osborne.

JAPAN. Total Membership, 22.

Members.—***Kobe.***—N. Shiraishi. ***Kyoto.***—U. Ogawa, S. Tanabe. ***Tokyo.***—I. Hiroi, C. Kadono, S. Kondo, T. Kondo, M. Otagawa, M. Sengoku, T. Tsuji, J. Yamaguchi. ***Yokohama.***—A. J. Bowie.

Associate Members.—***Gunbaken.***—Y. Wada. ***Kumamoto.***—T. Kawaguchi. ***Osaka.***—S. Sekiba. ***Sendai.***—C. Oinouye. ***Takow.***—E. Watanabe. ***Tokyo.***—K. Ichinose, H. Inagaki, M. Kabashima.

Associates.—***Kyoto.***—K. Futami.

Juniors.—***Tokyo.***—T. Chiba.

PHILIPPINE ISLANDS. Total Membership, 38.

Members.—***Cavite.***—E. H. Brownell. ***Manila.***—J. F. Case, L. F. Goodale, C. E. Gordon, H. L. Higgins, C. W. Hubbell, O. L. Ingalls, W. B. Poland, E. P. Shuman, C. G. Wrentmore. ***Olongapo.***—R. E. Bakenhus.

Associate Members.—***Cebu.***—C. H. Farnham. ***Iloilo.***—B. B. Harris. ***Manila.***—C. Bradshaw, W. C. Bunnel, H. F. Cameron, M. Cilley, A. Gideon, C. N. Kast, C. W. Keith, H. B. Kirkpatrick, G. K. Larrison, H. P. Linnell, F. D. Nash, C. M. Pritchett, S. D. Rockenbach, W. H. Waugh.

Associates.—***Manila.***—E. P. Thompson.

Juniors.—***Manila.***—G. E. Burnham, A. W. Bushell, H. W. Corp, S. G. Cutler, G. W. Davis, E. L. Driggs, E. L. Lundgren, S. W. Moore, C. G. Morrison, A. S. Russell.

STRAITS SETTLEMENTS. Total Membership, 2.

Members.—***Singapore.***—S. Tomlinson.

Associate Members.—***Singapore.***—H. M. Butterfield.

AUSTRALASIA.

Total Membership, 21.

Members.—***Adelaide, Australia.***—A. B. Moncrieff. ***Almaden, Australia.***—A. S. Frew. ***Brisbane, Australia.***—J. B. Henderson. ***Christchurch, New Zealand***—C. J. R. Williams. ***Marrickville, Australia.***—R. Watkins. ***Melbourne, Australia.***—J. M. Coane, T. W. Fowler, G. Higgins, M. E. Kernot, E. Mead. ***Narbethong, Australia.***—J. T. N. Anderson. ***Newcastle, Australia.***—P. Allan. ***South Yarra, Australia.***—H. C. Mais. ***Sydney, Australia.***—W. H. Warren.

Associate Members.—***Adelaide, Australia.***—H. F. Nichols. ***Chelmer, Australia.***—R. D. A. Frew. ***Essendon, Australia.***—W. M. Pullar. ***Levin, New Zealand.***—W. S. Charlsworth. ***Melbourne, Australia.***—E. Manchester.

Associates.—*Sydney, Australia.*—H. L. Hughes.

Juniors.—*Wanganui, New Zealand.*—E. Crow.

ADDRESS UNKNOWN. Total, 9.

Members.—W. Crawford, E. D. Graves, J. A. Seddon.

Associate Members.—C. C. Boyer, E. H. Welles.

Juniors.—J. H. Sawyer, A. A. Schlickeisen.

Fellows.—E. W. Coit, G. Merritt.

TOTAL MEMBERSHIP, 5 314.

SUMMARY OF GEOGRAPHICAL DISTRIBUTION.

NORTH AMERICA.

CANADA		100
MEXICO		67
UNITED STATES.		
Alabama	28	
Alaska	1	
Arizona	19	
Arkansas	12	
California	302	
Colorado	70	
Connecticut	75	
Delaware	16	
District of Columbia	101	
Florida	26	
Georgia	36	
Hawaii	13	
Idaho	33	
Illinois	270	
Indiana	30	
Iowa	22	
Kansas	31	
Kentucky	37	
Louisiana	38	
Maine	29	
Maryland	58	
Massachusetts	269	
Michigan	87	
Minnesota	57	
Mississippi	22	
Missouri	164	
Montana	33	
Nebraska	19	
Nevada	6	
New Hampshire	9	
New Jersey	183	
New Mexico	7	
New York	1 484	
North Carolina	19	
North Dakota	6	
Ohio	154	
Oklahoma	14	
Oregon	58	
Pennsylvania	472	
Rhode Island	48	
South Carolina	16	
South Dakota	9	
Tennessee	46	
Texas	75	
Utah	26	
Vermont	7	
Virginia	67	
Washington	105	
Carried forward	4 709	167
Brought forward	4 709	167
West Virginia	31	
Wisconsin	37	
Wyoming	15	4 792

CENTRAL AMERICA.

COSTA RICA	5	
HONDURAS	1	
NICARAGUA	1	
PANAMA	34	41

SOUTH AMERICA.

ARGENTINE REPUBLIC	10	
BOLIVIA	4	
BRAZIL	17	
CHILI	4	
COLOMBIA	5	
ECUADOR	1	
PERU	9	
URUGUAY	1	51

WEST INDIA ISLANDS.

CUBA	42	
DOMINICA	1	
JAMAICA	2	
PORTO RICO	10	
SANTO DOMINGO	5	60

EUROPE.

AUSTRIA	3	
DENMARK	2	
FRANCE	5	
GERMANY	3	
GREAT BRITAIN	44	
ITALY	2	
NETHERLANDS	2	
NORWAY	3	
RUSSIA	7	
SPAIN	1	
SWEDEN	3	
SWITZERLAND	2	77

AFRICA.

Total in Africa		9

ASIA.

CHINA	17	
COREA	1	
INDIA	7	
JAPAN	22	
PHILIPPINE ISLANDS	38	
STRAITS SETTLEMENTS	2	87

AUSTRALASIA.

Total in Australasia		21
Address Unknown		9

Total Membership, 5 314.

SUBSCRIBERS TO THE BUILDING FUND.

1881 to 1886.

The names of deceased subscribers to this fund, and of those whose address is unknown, have been omitted from this list, and the names of many living subscribers have, with their consent, also been omitted.

Boston Gas Light Company......................24 West St., Boston, Mass.

Boyd, Charles R..Wytheville, Va.

Griswold, Frank L..............Cruz del Eje, Cordoba, Argentine Republic.

Maher & Brayton..Cleveland, Ohio.

Sorzano, Julio F..............................52 Broadway, New York City.

Towle, Stevenson...........................7 East 42d St., New York City.

PAST AND PRESENT OFFICERS

AND YEARS IN WHICH THEY HELD OFFICE.

The figures of the year during which office was held are, to save space, printed without those of the century. In some cases they do not show the year in which office was taken; for instance, an officer whose term extended from November, 1873, to November, 1875, appears in this table as having held office during 1874 and 1875, or 74–75.

The names of deceased members are printed in italics.

Name.	President.	Vice-President.	Secretary.	Treasurer.	Director.
Adams, Arthur Lincoln	......	......	......	......	07–09
Adams, Julius Walker	74–75	68–73	......	......	53, 76
Allen, Horatio	72–73	......	......	......	......
Andrews, Horace	......	......	......	......	08–10
Archbald, James	......	......	......	......	87
Bates, Onward	09	06–07	......	......	......
Becker, Max Joseph	89	......	......	......	......
Belknap, William Ethelbert	......	......	......	......	10
Bensel, John Anderson	10	07–08	......	......	99–01
Benzenberg, George Henry	07	01–02	......	......	95–97
Bissell, Hezekiah	......	......	......	......	05–07
Bogart, John	......	......	78–90	76–77, 91–94	73–75
Boller, Alfred Pancoast	......	......	70–71	......	72
Bontecou, Daniel	......	......	......	......	96–98
Bouscaren, Louis Gustave Frederic	......	03–04	......	......	81
Bowman, Austin Lord	......	......	......	......	05–07
Brackett, Dexter	......	......	......	......	08–10
Briggs, Josiah Ackerman	......	......	......	......	01–03
Browne, George Hamilton	......	......	......	......	95–97
Brush, Charles Benjamin	......	92–93	......	......	88–91
Buchholz, Carl Waldemar	......	......	......	......	99–01
Buck, Leffert Lefferts	......	......	......	......	92–94
Buck, Richard Sutton	......	......	......	......	02–04
Burr, William Hubert	......	......	......	......	94–96
Carter, Edward Carlos	......	......	......	......	01–03

Name.	President.	Vice-President.	Secretary.	Treasurer.	Director.
Cartwright, Robert	......	99–00	......	......	95–97
Casey, Thomas L.*	......	......	......	......	82
Chanute, Octave	91	80–81	......	......	74–76, 85
Chesbrough, Ellis Sylvester	78	......	......	......	70
Chesbrough, I. C.*	......	......	......	......	55–67
Christie, James	......	......	......	......	07–09
Churchill, Charles Samuel	......	......	......	......	08–10
Clark, Jacob Merrill	......	72–73	......	......	70–71
Clarke, Eliot Channing	......	......	......	......	89
Clarke, Thomas Curtis	96	71	......	......	79
Cohen, Mendes	92	90	......	......	88
Collingwood, Francis	......	......	91–94	......	73–76
Cooper, Theodore	......	......	......	......	84–85
Copeland, Charles W.	......	53–69	......	......	......
Corthell, Elmer Lawrence	......	89, 93–94	......	......	......
Craighill, William Price†	94	......	......	......	92–93
Craven, Alfred	......	......	......	......	03–05
Craven, Alfred Wingate	70–71	54–67	......	......	53, 68–69, 72–73
Croes, John James Robertson	01	88	......	78–87	77
Crosby, Benjamin Lincoln	......	......	......	......	97–99
Crowell, Foster	......	......	......	......	93–95
Curtis, Fayette Samuel	......	04–05	......	......	95–97
Curtis, William Giddings	......	......	......	......	90
Davis, Joseph Phineas	......	84	......	......	78, 81–83
Davison, George Stewart	......	......	......	......	03–05
Deyo, Solomon LeFevre	......	04–05	......	......	98–00
Dresser, George Warren	......	......	......	......	82
Eads, James Buchanan	......	82	......	......	......
Ellis, John Waldo	......	......	......	......	04–06
Ellis, Theodore Grenville	......	74–77	......	......	79
Ely, Theodore Newel	......	......	......	......	92–93
Endicott, Mordecai Thomas	......	08–09	......	......	01–03
Fanning, John Thomas	......	10	......	......	93–95
Fink, Albert	80	78–79	......	......	......
Fisher, Edwin Augustus	......	......	......	......	05–07
FitzGerald, Desmond	99	95–96	......	......	92–94
Flad, Henry	86	83	......	......	......
Foote, Arthur DeWint	......	......	......	......	10

---

* Resigned.

† Elected President during his term of office as Director.

PAST AND PRESENT OFFICERS

Name.	President.	Vice-President.	Secretary.	Treasurer.	Directo
Ford, James K.*	......	......	......	......	68–69
Forney, Matthias N.*	......	......	......	......	77
Forsyth, Robert	......	......	......	......	87
Francis, James Bicheno	81	70, 79–80	......	......	......
Frazier, James Lewis	......	......	......	......	02–04
Freeman, John Ripley	......	02–03	......	......	96–98
Fteley, Alphonse	98	89–91	......	......	88
Fuertes, Estevan Antonio	......	......	......	......	92
Gardiner, Edward	......	53	54	54	......
Gardner, William Montgomery	......	......	......	.....	09–10
Gibbs, George	......	......	......	......	06–08
Gillmore, Quincy Adams	......	......	......	......	76
Gorsuch, Robert Bennett	......	......	53	53	......
Gottlieb, Abraham	......	......	......	......	92–93
Gowen, Charles Sewall	......	......	......	......	04–06
Graff, Frederic	85	......	......	......	84
Gray, Samuel Merrill	......	92	......	......	......
Green, Bernard Richardson	......	06–07	......	......	94–96
Greene, George Sears	76–77	......	......	......	68–69, 7 73, 75, 77–79
Greene, George Sears, Jr.	......	85	......	88–90	82–84, 8
Gzowski, Sir Casimir Stanislaus	......	......	......	......	94
Haines, Henry Stevens	......	01–02	......	......	97–99
Hamilton, William Gaston	......	......	......	......	83–87
Harrison, Charles Lewis	......	.....	......	......	08–10
Harrod, Benjamin Morgan	97	95–96	......	......	92–94
Hazen, Allen	......	......	......	......	07-09
Hering, Rudolph	......	00–01	......	......	91, 97–9
Hermany, Charles	04	91	......	......	80
Herschel, Clemens	......	......	......	......	91
Hill, Albert Banks	......	......	......	......	92
Hodgdon, Frank Wellington	......	......	......	......	07–09
Holley, Alexander Lyman	......	77	......	......	76
Holman, Minard Lafever	......	05–06	......	......	......
Horton, Horace E.	......	......	......	......	07–09
Hunt, Charles Warren	......	......	95–10	......	......
Hutton, William Rich	......	96–97	......	......	84–86

* Resigned.

Name.	President.	Vice-President.	Secretary.	Treasurer.	Director.
Ackson, William					02–04
Ohnson, James M.					06–08
ohnson, Lorenzo Medici					97–99
Ohnson, Thomas H.					00–02
Ust, George Alexander					96–98
Atté, Walter					85, 89
Eefer, Thomas Coltrin	88	86–87			82
Ennedy, John					98–00
Kennedy, William Harlin†					02–03
Kiersted, Wynkoop					06–08
Kimball, George Albert					10
Kirkwood, James Pugh‡	68				53–67
Kittredge, George Watson					08–10
Knap, Joseph Moss				00–10	94–96
Kuichling, Emil		05–06			01–03
Landreth, Olin Henry					93–95
Landreth, William Barker					05–07
Laurie, James	53–67				
Leverich, Gabriel			72–77		
Lewis, Eugene Castner					03–05
Lewis, Nelson Peter					04–06
Loomis, Horace					10
Loweth, Charles Frederick					10
Ludlow, William					90
Macdonald, Charles	08	93–94			71, 74–75
MacLeod, John		92			
McAlpine, William Jarvis‡	68–69				54–67, 70
McDonald, Hunter		10			03–05
McMath, Robert Emmet					89
McNulty, George Washington					92–93
McVean, John Jay					98–00
Manley, Henry					98–00
Martin, Charles Cyril		94–95			
Marx, Charles David					04–06
Mead, Elwood					03–05
Mendell, George Henry		97–98			

---

† Elected Director Dec. 3d, 1901, to fill the vacancy caused by the death of George A. Quinlan.

‡ Mr. Kirkwood resigned the Presidency August 5th, 1868, and Mr. McAlpine was elected for the unexpired term.

PAST AND PRESENT OFFICERS

Name.	President.	Vice-President.	Secretary.	Treasurer.	Directo
Merrill, William Emery	......	......	......	......	83
Metcalf, William	93	......	......	......	83–84
Meyer, Thomas C.†	......	......	69	......	......
Modjeski, Ralph	......	......	......	......	04–06
Moore, Robert	02	88, 99–00	......	......	92–93
Mordecai, Augustus	......	......	......	......	95–97
Morell, W. H.	......	......	......	......	53
Morison, George Shattuck	95	......	......	......	......
Morris, Henry Gurney	......	......	......	......	86
Morse, Henry Grant	......	......	......	......	97–99
Morse, James Otis	......	......	55–69	55–75	54–67, 77
Myers, Charles Hayward	......	......	......	......	92
Myers, Edmund Trowbridge Dana	......	......	......	......	92
Nichols, Othniel Foster	......	......	......	......	92–93
Noble, Alfred‡	03	00–01	......	......	95
North, Edward P.	......	98–99	......	......	91
Ockerson, John Augustus	......	07–08	......	......	......
O'Rourke, John Francis	......	......	......	......	00–02
Osborn, Frank Chittenden	......	......	......	......	01–03
Osgood, Joseph Otis	......	......	......	......	03–05
Owen, James	......	......	......	......	97–99
Paine, Charles	83	......	......	......	......
Paine, William H.	......	82–84	......	......	77–81
Parsons, William Barclay	......	......	......	......	96–98
Pegram, George Herndon	......	09–10	......	......	02–04
Peterson, Peter Alexander	......	96–97	......	......	92–93
Pierson, George Spencer	......	......	......	......	05–07
Pope, Willard Smith	......	......	......	......	93–95
Pratt, J. W.	......	......	......	......	54
Prosser, Thomas	......	......	......	......	70
Prout, Henry Goslee	......	......	......	......	93–95
Quinlan, George Austin	......	......	......	......	00–01
Ramsey, Joseph, Jr.	......	......	......	......	00–02
Read, Robert Leland	......	......	......	......	92–93
Richardson, Henry Brown	......	......	......	......	00–02
Ricketts, Palmer Chamberlaine	......	......	......	......	99–01
Roberts, Percival, Jr.	......	......	......	......	10

---

† November 3d, 1869, to January 5th, 1870.

‡ Elected Director Nov. 5th, 1895, to fill the vacancy caused by the death of Willard S. Pope.

Name.	President.	Vice-President.	Secretary.	Treasurer.	Director.
Roberts, William Milnor	79	74–76, 78	......	......	77
Rowland, Thomas Fitch	......	86–87	......	......	71–73
Schneider, Charles Conrad	05	02–03	......	......	87, 98–00
Schuyler, James Dix	......	03–04	......	......	92, 99–01
Seaman, Henry Bowman	......	......	......	......	00–02
See, Horace*	......	......	......	......	96–98
Sherrerd, Morris Robeson	......	......	......	......	05–07
Shinn, William Powell	90	......	......	......	89
Sidell, W. H.	......	......	......	......	53
Smith, Charles Shaler	......	......	......	......	78
Smith, Charles Vandervoort	......	......	......	......	78–81
Smith, J. Waldo	......	......	......	......	06–08
Smith, T. Guilford	......	......	......	......	94–96
Sooysmith, Charles	......	......	......	......	95–97
Stanton, Robert Brewster	......	......	......	......	94–96
Stearns, Frederic Pike	06	98–99	......	......	93–95
Storey, William B., Jr.	......	......	......	......	06–08
Strobel, Charles Louis†	......	......	......	......	86, 94
Stuart, Francis Lee	......	......	......	......	09–10
Sumner, Horace Augustus	......	......	......	......	09–10
Swain, George Fillmore	......	08–09	......	......	01–03
Swensson, Emil	......	09–10	......	......	06–08
Symons, Thomas William*	......	......	......	......	96–98
Talbot, Arthur Newell	......	......	......	......	09–10
Talcott, William Hubbard	......	......	......	......	54–68
Thompson, Samuel Clarence	......	......	......	......	09–10
Thomson, John	......	......	......	95–99	92–94
Tillson, George William	......	......	......	......	07–09
Towle, Stevenson	......	......	......	......	87–88
Turner, Edmund Kimball	......	......	......	......	99–01
Van Buren, Robert	......	......	......	......	90
Van Hoesen, Edmund French	......	......	......	......	02–04
Van Horne, John Garret	......	......	......	......	92
Van Winkle, Edgar Beach	......	......	......	......	80
Vaughan, Frederic Willis	......	......	......	......	85

---

* Resigned.

† Elected Director to fill the vacancy caused by the death of Abraham Gottlieb, Feb. 9th, 1894.

Name.	President.	Vice-President.	Secretary.	Treasurer.	Director
Voorhees, Theodore	......	......	......	......	90
Wallace, John Findley	00	97–98	......	......	......
Ward, John Frothingham*	......	......	......	......	68–72
Warren, Gouverneur K.*	......	......	......	......	80
Webster, George Smedley	......	......	......	......	04–06
Welch, Ashbel†	82	81	......	......	......
Whinery, Samuel	......	92–93	......	......	91, 99–0
Whitcomb, Henry Donald	......	......	......	......	94–96
White, William Howard	......	......	......	......	86
Whitman, Thomas Jefferson	......	85	......	......	......
Whittemore, Don Juan	84	......	......	......	81
Wilgus, William John	......	......	......	......	02–04
Wilkins, William Glyde	......	......	......	......	09–10
Williams, Gardner Stewart	......	......	......	......	08–10
Wilson, Joseph Miller	......	94–95	......	......	88
Wisner, George Y.	......	......	......	......	98–00
Wood, De Volson*	......	......	......	......	74
Worthen, William Ezra	87	......	......	......	72

* Resigned.

† Mr. Welch died September 25th, 1882, during his term of office as President.

DECEASED MEMBERS

H. M., Honorary Member. M., Member. A. M., Associate Member. F., Fellow.
A., Associate. J., Junior.

Name.	Date of Election.	Date of Death.	Memoirs.*
Abbott, Arthur Vaughan	J. Jan. 5, 1881. M. Dec. 4, 1901.	Dec. 1, 1906.	....
Abbott, Job	M. April 1, 1891.	Aug. 18, 1896.	*XXXVI, 538*
Abert, John James	H. M. Mar. 2, 1853.	Jan. 27, 1862.	XIX, 88
Abert, Sylvanus Thayer	M. Sept. 21, 1870.	Aug. 11, 1903.	*LIX, 521*
Ackenheil, Charles	M. Feb. 2, 1887.	June 20, 1890.	XVII, 137
Adams, Julius Walker	M. Nov. 5, 1852. H. M. Oct. 26, 1888.	Dec. 13, 1899.	....
Adgate, George	M. April 1, 1896.	Jan. 23, 1909.	*LXV, 514*
Ainslie, George	F. May 28, 1872.	Sept. 6, 1878.	XV, 41
Ainslie, James W.	F. May 28, 1872.	Sept. 13, 1902.	....
Ainsworth, Danforth Hurlbut	M. Mar. 3, 1886.	April 24, 1904.	*LIV, 522*
Aldrich, James Colwell	M. May 7, 1873.	April 3, 1900.	*XLV, 617*
Allaire, William Miller	J. Mar. 2, 1881.	Dec. 14, 1884.	XIX, 67
Allen, Horatio	M. Dec. 4, 1867. H. M. Mar. 4, 1874.	Dec. 31, 1889.	XVI, 180
Allen, Theodore	M. Nov. 16, 1870.	Sept. 18, 1890.	XVII, 240
Allen, William Albert	M. May 6, 1891.	Mar. 21, 1896.	*XXXVI, 539*
Allis, Edward Phelps	F. Aug. 4, 1883.	April 1, 1889.	XV, 168
Ambrose, William Creelman	M. April 4, 1888.	Jan. 3, 1909.	....
Anderson, Adna	M. Sept. 2, 1874.	May 15, 1889.	XV, 166
Ansley, George Doane	M. Sept. 4, 1878.	Sept. 22, 1883.	XV, 109
Armington, James Hervey	M. July 6, 1870.	Oct. 14, 1906.	....
Arthur, William Young	M. Dec. 4, 1867. F. Sept. 20, 1870.	Feb. 15, 1876.	....
Aspinwall, William Howard	F. July 9, 1870.	Jan. 18, 1875.	*XXXVI, 598*
Asserson, Peter Christian	M. July 5, 1882.	Dec. 6, 1906.	....
Atwood, William Henry	M. May 4, 1881.	Sept. 4, 1890.	XVII, 205
Avery, John	M. Dec. 4, 1867.	Jan. 30, 1884.	XI, 117
Bache, Alexander Dallas	H. M. Mar. 2, 1853.	Feb. 17, 1867.	*XXXVI, 522*
Bacon, John Watson	M. July 12, 1877.	Feb. 27, 1907.	....

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

DECEASED MEMBERS B

Name.	Date of Election.	Date of Death.	Memoirs
BAIER, JULIUS	J. Sept. 7, 1887. A. M. June 1, 1892. M. Feb. 6, 1901.	May 8, 1905.	....
BAILEY, GEORGE IRVING	M. Oct. 1, 1890.	Mar. 28, 1908.	*LXI, 55*
BAILEY, THOMAS NORTON	M. Nov. 7, 1883.	April 20, 1886.	XVI, 18
BAKER, *Sir* BENJAMIN	H. M. May 5, 1897.	May 19, 1907.	....
BAKER, WILLIAM LATIMER	J. Jan. 6, 1875. M. Nov. 6, 1878.	May 28, 1888.	XV, 11
BALDWIN, HENRY FURLONG	A. M. Dec. 7, 1892. M. Feb. 6, 1895.	June 17, 1909.	....
BALL, ERNEST STEARNS	J. May 2, 1905.	Nov. 22, 1909.	....
BANNISTER, CHARLES KIMBALL	M. May 3, 1893.	Jan. 10, 1901.	....
BARBER, AMZI LORENZO	F. Mar. 19, 1886.	April 18, 1909.	....
BARBOUR, WILLIAM SULLIVAN	M. April 17, 1872.	Feb. 24, 1889.	XV, 14
BARNARD, JOHN GROSS	M. Sept. 15, 1869. H. M. April 7, 1873.	May 14, 1882.	XIII, 13
BARNES, DAVID LEONARD	M. July 2, 1890.	Dec. 15, 1896.	*XLI, 61*
BARNES, JAMES	M. Mar. 13, 1853.	Feb. 12, 1869.	*XXXVI, 54*
BARNES, OLIVER WELDON	M. July 6, 1881.	Nov. 14, 1908.	....
BARNSLEY, GEORGE THOMAS	J. May 31, 1892. A. M. May 7, 1894. M. Feb. 6, 1906.	Oct. 23, 1909.	....
BARR, JACOB NEFF	M. Nov. 7, 1888.	May 15, 1904.	....
BARRIGER, JOHN WALKER, JR.	J. May 31, 1898. A. M. April 2, 1902.	Dec. 19, 1902.	*LVI, 47*
BARTLETT, WINTHROP	M. Jan. 2, 1889.	Jan. 16, 1899.	....
BASSELL, BURR	M. Nov. 4, 1903.	Feb. 25, 1905.	....
BATTERSON, JAMES GOODWIN	F. June 7, 1876.	Sept. 18, 1901.	....
BAUMANN, EDWARD	A. June 2, 1880.	Jan. 26, 1889.	XV, 11
BAYLEY, GEORGE WILLIAM READ	M. July 10, 1872.	Dec. 14, 1876.	IV, 5
BEARDSLEY, FRANK CHESTER	M. Nov. 7, 1894.	July 1, 1895.	XXI, 18
BECKER, MAX JOSEPH	M. Aug. 7, 1872.	Aug. 23, 1896.	*XXXVII, 55*
BECKLER, ELBRIDGE HARLOW	M. April 6, 1892.	Aug. 26, 1908.	....
BEHRENS, WILLIAM FREDERIC	J. Nov. 6, 1889. A. M. June 7, 1893.	Feb. 6, 1894.	XX, 8
BELKNAP, MORRIS SHEPPARD	M. Aug. 7, 1872.	July 19, 1890.	XVI, 16
BELL, JAMES E.	M. Mar. 5, 1879.	June 9, 1879.	V, 9
BENTLEY, HENRY ADAMSON	M. Mar. 2, 1881.	May 13, 1889.	....
BENYAURD, WILLIAM H. H.	M. Nov. 3, 1875.	Feb. 7, 1900.	....
BERESFORD, FRANK	J. Sept. 7, 1887.	Dec. 12, 1887.	*XXXVI, 594*
BERG, WALTER GILMAN	M. Feb. 5, 1896.	May 12, 1908.	....
BERGENGREN, FRITZ CARL ANDERS GEORG	A. M. Dec. 2, 1896.	Aug. 8, 1904.	....

The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

Name.	Date of Election.	Date of Death.	Memoirs.*
BERRIAN, RICHARD MILFORD	M. May 4, 1887.	Dec. 23, 1907.	*LXII, 550*
BIRCH-NORD, CARL WILLIAM	J. Oct. 30, 1906. A. M. Nov. 4, 1908.	Sept. 15, 1909.	....
BIRKS, ARTHUR HENRY	J. April 5, 1904. A. M. Nov. 7, 1906.	Aug. 29, 1907.	....
BISHOP, GEORGE H.	M. Aug. 7, 1872.	Aug. 20, 1909.	....
BISHOP, THOMAS SPARKS	M. Sept. 2, 1885.	Nov. 13, 1898.	*XLI, 621*
BLACKWELL, CHARLES	M. Sept. 7, 1881.	Dec. 29, 1906.	*LIX, 531*
BLAISDELL, ANTHONY HOUGHTALING	M. Mar. 3, 1880.	Sept. 9, 1905.	*LVI, 464*
BLAKE, EDWARD JOSIAH	M. April 3, 1889.	May 29, 1902.	....
BLICKENSDERFER, JACOB	M. June 1, 1881.	Feb. 26, 1899.	....
BLISS, HENRY ISAAC	M. Sept. 5, 1883.	July 10, 1896.	*XXXVI, 541*
BLUNDEN, HENRY D.	J. Jan. 5, 1876. M. Feb. 4, 1880.	Jan. 7, 1889.	*XXXVI, 542*
BODFISH, SUMNER HOMER	M. Oct. 2, 1889.	May 17, 1894.	XX, 96
BOEKE, AUGUST WILLIAM	M. Sept. 3, 1890.	Oct. 24, 1894.	XX, 204
BOGART, JAMES PETER	J. Jan. 4, 1882. M. July 3, 1895.	Dec. 24, 1903.	*LII, 545*
BOND, FREDERICK WINN	M. Dec. 7, 1898.	July 12, 1903.	*LI, 452*
BOOKER, BERNARD FRANK	J. Oct. 7, 1885. M. June 2, 1891.	July 21, 1894.	XX, 183
BOTH, CARL CHRISTIAN ADOLPH	M. Sept. 2, 1891.	Jan. 12, 1906.	....
BOUSCAREN, LOUIS GUSTAVE FREDERIC	M. April 7, 1875.	Nov. 6, 1904.	*LIX, 533*
BOUTON, NATHANIEL S.	F. Dec. 30, 1872.	April 3, 1908.	....
BOWMAN, JOSEPH HOCKMAN	A. M. Dec. 2, 1903.	†	....
BOYLE, OLIN MCCLINTOCK, JR.	J. Mar. 5, 1907.	Aug. 19, 1908.	*LXIV, 591*
BRADBURY, HENRY ROBERT	A. July 6, 1881.	July 3, 1901.	....
BRECKINRIDGE, CABELL	M. June 1, 1881.	Nov. 13, 1907.	*LXV, 529*
BREEN, HOWARD	M. April 4, 1888.	Feb. 14, 1909.	....
BRIDGFORD, JOHN	F. Jan. 14, 1871.	Mar. 8, 1898.	....
BRIGGS, ALBERT DWIGHT	F. May 17, 1870.	Feb. 20, 1881.	XV, 132
BRIGGS, ROBERT	M. Oct. 19, 1870.	July 24, 1882.	*XXXVI, 542*
BRINCKERHOFF, HENRY WALLER	M. Nov. 7, 1883.	Sept. 7, 1909.	....
BRODHEAD, CALVIN EASTON	M. Feb. 21, 1872.	April 29, 1907.	*LX, 579*
BROUGH, REDMOND JOHN	M. Sept. 1, 1880.	July 21, 1883.	XII, 40
BROWN, ALBA FISK	M. Sept. 7, 1887.	April 22, 1906.	....
BROWN, CHARLES IRWIN	M. Jan. 7, 1891.	Mar. 23, 1899.	....
BROWN, JOHN MILTON	M. April 1, 1874.	June 16, 1874.	I, 170
BRUNER, DANIEL PASTORIUS	J. Sept. 6, 1876. M. May 7, 1879.	Aug. 29, 1901.	....

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

† Date of death unknown.

DECEASED MEMBERS B-C

Name.	Date of Election.	Date of Death.	Memoirs.
BRUSH, CHARLES BENJAMIN	A. Sept. 6, 1871. M. Sept. 5, 1877.	June 3, 1897.	....
BRYNN, PER	A. M. Feb. 4, 1903.	Feb. 10, 1906.	*LVII, 52*
BUCK, LEFFERT LEFFERTS	M. Feb. 3, 1875.	July 17, 1909.	....
BUCKHOUT, ISAAC CRAIG	M. July 15, 1872.	Sept. 27, 1874.	I, 17
BURDEN, HENRY	H. M. Mar. 2, 1853.	Jan. 19, 1871.	....
BURDEN, JAMES ABERCROMBIE	M. July 2, 1879.	Sept. 23, 1906.	....
BURNS, JUSTIN	A. M. April 6, 1898.	Nov. 14, 1905.	*LVII, 52*
BURNS, ROBERT BRUCE	M. Sept. 5, 1900.	June 21, 1906.	....
BURR, JAMES DEWEY	M. April 5, 1876.	May 5, 1886.	XII, 10
BURROWES, FRANCIS SMITH	M. June 6, 1888.	Feb. 15, 1909.	....
BURTON, STANDISH BARRY	M. June 1, 1898.	Aug. 13, 1904.	*LV, 44*
BUTTS, ELIJAH POLHILL	J. Nov. 3, 1886.	Jan. 11, 1892.	XVIII, 12
BUXTON, CLIFFORD	M. May 6, 1885.	Jan. 12, 1910.	....
CAMP, JONATHAN, JR.	M. Dec. 31, 1873.	April 16, 1874.	I, 18
CAMPBELL, ALBERT JOHNSTONE	A. M. May 2, 1894.	Mar. 23, 1907.	*LIX, 56*
CAMPBELL, ALLAN	M. Feb. 19, 1868. H. M. Mar. 1, 1892.	Mar. 18, 1894.	XX, 17
CAMPBELL, CHARLES EDWARD HENRY	M. Oct. 3, 1883.	Dec. 6, 1902.	*LII, 54*
CARD, JOSEPH P.	A. Sept. 5, 1883.	Oct. 22, 1894.	XXI, 6
CARD, WILLIAM WARREN	M. Sept. 5, 1883.	April 4, 1903.	....
CAROTHERS, DANIEL DAWSON	M. April 4, 1894.	Jan. 2, 1909.	*LXIV, 58*
CARPENTER, CLARENCE ALLAN	M. May 2, 1888.	Nov. 9, 1899.	....
CARREL, FREDERICK JANVRIN	M. Mar. 5, 1884.	May 2, 1894.	*XXXVII, 55*
CARTWRIGHT, HENRY	M. Sept. 6, 1876.	June 30, 1881.	VII, 12
CARTWRIGHT, ROBERT	M. July 10, 1872.	June 4, 1905.	....
CARY, EDGAR SHELDON	M. Nov. 1, 1882.	Jan. 5, 1883.	*XLVI, 55*
CASS, GEORGE WASHINGTON, JR.	F. Mar. 30, 1871.	Mar. 21, 1888.	*XXXVI, 59*
CATT, GEORGE WILLIAM	M. Sept. 7, 1892.	Oct. 8, 1905.	....
CHASE, SAMUEL STEWART	M. Dec. 8, 1868. F. Mar. 12, 1870.	May 29, 1873.	I, 4
CHASE, WILLIAM BEVERLY	M. Sept. 6, 1899.	Oct. 27, 1908.	*LXIII, 42*
CHENEY, JOHN EUGENE	M. May 7, 1884.	Sept. 25, 1906.	*LIX, 53*
CHENEY, NATHANIEL	F. June 21, 1870.	June 29, 1901.	....
CHESBROUGH, ELLIS SYLVESTER	M. June 17, 1868.	Aug. 18, 1886.	XV, 160
CHURCH, GEORGE EARL	M. Nov. 2, 1887.	Jan. 5, 1910.	....
CISNEROS, FRANCISCO JAVIER	M. May 15, 1872.	July 7, 1898.	*XLI, 622*
CLAPP, LORENZO RUSSELL	M. Feb. 1, 1888.	Aug. 13, 1902.	*XLIX, 341*
CLARK, IRA EDGAR	J. Feb. 6, 1878.	May 23, 1882.	VIII, 92
CLARK, JACOB MERRILL	M. Jan. 29, 1868.	Dec. 21, 1894.	XX, 203

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

Name.	Date of Election.	Date of Death.	Memoirs.*
Clark, John Howard	M. Nov. 4, 1903.	Oct. 13, 1907.	....
Clarke, Henry Wadsworth	M. Mar. 15, 1871.	Feb. 23, 1892.	XVIII, 93
Clarke, Thomas Curtis	M. Mar. 18, 1868. F. May 20, 1872.	June 15, 1901.	*L, 495*
Cleemann, Thomas Mutter	M. Oct. 1, 1879.	Nov. 16, 1893.	XX, 69
Clemens, Ernest Victor	M. Mar. 1, 1893.	Sept. 3, 1893.	XX, 161
Clement, Victor M.	F. Jan. 8, 1890.	April 28, 1903.	....
Cleverdon, Henry Lawrence	A. M. Mar. 1, 1899.	Aug. 27, 1902.	*L, 507*
Cobb, Robert Linah	M. Jan. 2, 1890.	June 2, 1895.	*XXXVI, 545*
Cochran, A. P.	F. June 19, 1872.	April 26, 1886.	....
Coffin, Freeman Clarke	M. Feb. 6, 1895.	Nov. 11, 1906.	*LVIII, 532*
Colburn, Warren	M. Mar. 18, 1868.	Sept. 15, 1879.	VI, 4
Colburn, Zerah	M. Jan. 5, 1855.	April 26, 1870.	*XXXVI, 546*
Colby, Charles Lewis	F. July 31, 1883.	Feb. 26, 1896.	....
Coleman, Thomas Cooper	F. May 28, 1872.	Dec. 17, 1901.	....
Colman, Isaac D.	M. Feb. 27, 1869.	April 7, 1875.	I, 331
Connor, Addison	M. Jan. 5, 1887.	Jan. 4, 1891.	*XXXVI, 551*
Conro, Albert	F. June 13, 1883.	Jan. 10, 1901.	....
Constable, Casimir	M. June 17, 1868.	Feb. 6, 1905.	....
Cooke, Robert Latimer	M. April 17, 1872.	Aug. 11, 1877.	IV, 66
Cooper, Edward	F. Dec. 10, 1885.	Feb. 25, 1905.	....
Coppée, Henry St. Leger	M. Oct. 5, 1887.	May 8, 1901.	....
Correa, Edward Arnold	M. Mar. 7, 1900.	June 24, 1900.	*XLV, 621*
Coryell, Martin	M. Dec. 4, 1867.	Nov. 30, 1886.	XV, 133
Courtwright, Milton	F. June 11, 1870.	April 25, 1883.	....
Covode, James Henry	M. April 2, 1890.	Sept. 9, 1909.	....
Cox, Abraham Beekman	M. April 1, 1874.	Feb. ‡, 1906.	....
Coxe, Eckley Brinton	M. Feb. 7, 1877.	May 13, 1895.	*XXXVI, 552*
Crabb, Thomas	J. April 4, 1899.	Dec. 21, 1901.	....
Craighill, William Price	M. Oct. 7, 1885. H. M. Mar. 23, 1896.	Jan. 18, 1909.	*LXV, 517*
Craven, Alfred Wingate	M. Nov. 5, 1852.	Mar. 27, 1879.	VI, 24
Craven, Henry Smith	M. Dec. 3, 1884.	Dec. 7, 1889.	XVI, 217
Croes, John James Robertson	M. Dec. 4, 1867.	Mar. 17, 1906.	*LVIII, 524*
Crosby, Wilson	M. Sept. 15, 1869.	Dec. 18, 1904.	....
Cunningham, John Miller	A. M. Oct. 7, 1903.	Aug. 8, 1904.	*LIV, 537*
Cunningham, Paul Davis	A. M. Mar. 1, 1899.	July 13, 1901.	*LII, 556*
Curtis, Wendell Rhodes	J. Mar. 3, 1875. M. June 4, 1884.	Mar. 7, 1893.	XX, 86
Curtis, William Giddings	M. May 3, 1882.	June 15, 1900.	*XLV, 624*
Cushing, Oliver Edwards	M. July 10, 1872.	Jan. 17, 1890.	XVI, 166
Cushing, Robert Delano	A. M. Sept. 6, 1899.	Aug. 23, 1903.	....
Cushing, Samuel Barrett	M. Sept. 2, 1869.	July 17, 1873.	I, 43

---

* The italic references in this column are to the volume and page of *Transactions,* in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings,* where the Memoirs prepared earlier than that date will be found.

‡ Exact date of death unknown.

DECEASED MEMBERS C-D

Name.	Date of Election.	Date of Death.	Memoirs.
Cushing, Samuel Barrett	M. June 1, 1887.	Dec. 2, 1888.	*XLIX, 34*
Cutshaw, Wilfred Emory	M. Mar. 4, 1891.	Dec. 19, 1907.	....
Dagron, James Gustavus	M. Oct. 6, 1886.	May 25, 1895.	....
Davidson, Matthias Oliver	M. April 6, 1853.	Sept. 1, 1872.	XIX, 5
Davis, Charles	M. Sept. 15, 1869.	Feb. 20, 1907.	....
Davis, Frank Leslie	M. Sept. 6, 1905.	June 9, 1909.	....
Davis, Frank Paul	M. Feb. 1, 1888.	May 3, 1900.	....
Davis, John Woodbridge	A. June 3, 1885.	Nov. 7, 1902.	*XLIX, 37*
Deans, Charles Herbert	J. Dec. 3, 1890. A. M. May 6, 1896.	Mar. 7, 1909.	....
Dearborn, William Lee	M. Jan. 29, 1868.	Mar. 15, 1875.	I, 33
DeCourcy, Bolton Waller	M. Nov. 6, 1889.	April 1, 1900.	....
DeForest, George Thompson	A. M. Dec. 4, 1895.	July 25, 1901.	....
de Funiak, Frederick	M. May 7, 1873.	Mar. 29, 1905.	*LIV, 52*
DeGaray, Francisco	F. Aug. 31, 1883.	Sept. 2, 1896.	....
DeHaas, Adolph	J. Oct. 3, 1905.	Dec. 28, 1907.	....
Del Monte, Emilio	M. Dec. 4, 1895.	Mar. 20, 1902.	....
Derbishire, James Stewart	M. April 2, 1884.	Jan. 2, 1887.	XIII, 6
Dexter, George M.	M. Dec. 3, 1852.	Nov. 26, 1872.	I, 4
Dickinson, George Codwise	M. Feb. 5, 1890.	Jan. 24, 1892.	XVIII, 7
Dickinson, Pomeroy P.	M. Jan. 17, 1872.	Oct. 4, 1895.	*XLIII, 61*
Dillon, Sidney	F. Mar. 26, 1870.	June 9, 1892.	*XXXVI, 60*
Dimmick, John Bagley	M. July 10, 1907.	June ‡, 1909.	....
d'Invilliers, Camille Stanislaus	M. Jan. 4, 1888.	Jan. 2, 1910.	....
Dirks, Justus	H. M. June 2, 1880.	Dec. 26, 1886.	XIII, 4
Diven, Alexander Samuel	F. June 16, 1870.	June 11, 1896.	*XXXVII, 57*
Doane, Thomas	M. June 7, 1882.	Oct. 22, 1897.	*XXXIX, 69*
Doran, Frank C.	M. Sept. 5, 1883.	Oct. 15, 1898.	....
Dorsey, Edward Bates	M. June 4, 1879.	†	....
Downes, Stancliff Bazen	J. April 7, 1886.	April 21, 1895.	XXI, 10
Dresser, George Warren	M. July 5, 1876.	May 27, 1883.	XIX, 11
Duane, James	M. Mar. 2, 1892.	Jan. 12, 1899.	....
Duane, James Chatham	H. M. Nov. 20, 1886.	Nov. 8, 1897.	*XXXIX, 68*
DuBarry, Edmund Louis	A. Jan. 6, 1875.	Dec. 4, 1908.	....
Du Barry, Joseph Napoleon	M. Jan. 6, 1875.	Dec. 17, 1892.	XIX, 10
Dudley, Charles Benjamin	M. Mar. 2, 1892.	Dec. 21, 1909.	....
Dudley, Charles Tarbell	J. Sept. 6, 1904. A. M. Oct. 3, 1906.	Sept. 30, 1908.	*LXIV, 588*
Dun, James	M. June 7, 1876.	Feb. 23, 1908.	*LXI, 560*
Dunham, Charles Frederick	M. April 2, 1902.	June 13, 1903.	....

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

† Date of death unknown.

‡ Exact date of death unknown.

Name.	Date of Election.	Date of Death.	Memoirs.*
Durant, Thomas C.	F. Nov. 18, 1870.	Oct. 5, 1885.	*XXXVI, 602*
Dusenberry, Walter Lorton	J. Nov. 5, 1890.	May 13, 1909.	*LXV, 533*

Name.	Date of Election.	Date of Death.	Memoirs.*
Eads, James Buchanan	M. Dec. 16, 1868. F. Mar. 30, 1870.	Mar. 8, 1887.	XIII, 46
Earley, John Edwin	M. April 5, 1876.	Dec. 20, 1907.	*LXI, 562*
Eaton, Horace LaFayette	M. Feb. 1, 1893.	Nov. 23, 1895.	*XXXVI, 554*
Eayrs, Norman Wilder	M. June 3, 1885.	May 13, 1900.	....
Edge, George Washington	M. Mar. 4, 1874.	Jan. 1, 1880.	VI, 18
Edwards, Nathaniel Marsh	M. June 3, 1874.	†	....
Eldridge, Archibald Ronaldson	M. Oct. 2, 1901.	Jan. 17, 1907.	....
Elliott, George Harford	M. April 4, 1883.	Oct. 7, 1886.	XV, 110
Ellis, Nathaniel Webster	M. Feb. 2, 1881.	Jan. 16, 1889.	XV, 112
Ellis, Theodore Grenville	M. Feb. 17, 1869. F. Nov. 21, 1872.	Jan. 9, 1883.	*XXXVII, 557*
Ellsworth, Alfred Burnham	J. May 1, 1889.	Jan. 10, 1893.	XIX, 48
Ely, George Hervey	A. May 31, 1892.	Jan. 24, 1894.	....
Emack, Charles S.	M. July 6, 1870.	July 26, 1877.	IV, 65
Emerson, George Dana	M. Sept. 18, 1872.	Sept. 26, 1900.	....
Emery, Charles Edward	M. May 6, 1874.	June 1, 1898.	*XLII, 558*
Emigh, John H.	M. April 3, 1901.	Jan. 6, 1910.	....
Emmet, Thomas Addis	M. Nov. 5, 1852.	Jan. 12, 1880.	VI, 2
Emonts, William Alexis George	J. Sept. 6, 1876.	Nov. 5, 1887.	*XXXVI, 594*
Engle, Robert L.	M. Sept. 7, 1881.	Oct. 17, 1909.	....
Enos, George Wallace	J. Mar. 6, 1900.	Nov. 2, 1905.	....
Ensign, Elisha Williams	F. May 18, 1870.	Oct. 1, 1877.	....
Ericsson, John	H. M. Oct. 2, 1879.	Mar. 8, 1889.	....
Evans, Anthony Walton White	M. Dec. 4, 1867. F. Mar. 15, 1870.	Nov. 28, 1886.	XIII, 30
Evans, George Edwin	M. May 2, 1888.	April 14, 1908.	....
Evans, Louis Provost	M. Sept. 3, 1884.	Aug. 19, 1896.	....
Evans, Myron Edward	J. Jan. 3, 1895. A. M. Feb. 7, 1900.	Feb. 16, 1907.	....

Name.	Date of Election.	Date of Death.	Memoirs.*
Falconnet, Eugene F.	M. June 3, 1874.	Oct. 14, 1887.	XV, 135
Fales, Frank Lewis	A. M. April 6, 1904.	Oct. 5, 1905.	....
Fargo, William G.	F. May 6, 1870.	Aug. 4, 1881.	....
Farnam, Henry	F. Nov. 14, 1872.	Oct. 4, 1883.	*XXXVI, 605*
Farnham, Irving Tupper	M. May 1, 1907.	Sept. 19, 1908.	....
Farquhar, Francis Ulric	M. July 10, 1872.	July 3, 1883.	XV, 165
Fava, Francis Renatus, Jr.	M. Nov. 5, 1890.	Mar. 27, 1896.	....

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

† Date of death unknown.

DECEASED MEMBERS F-G

Name.	Date of Election.	Date of Death.	Memoirs
Feind, Anthony Leneste Bernhard	M. Jan. 2, 1890.	Aug. 21, 1894.	XX, 1
Felton, Samuel Morse	F. Mar. 23, 1870.	Jan. 24, 1889.	XIX,
Field, Burr Kellogg	M. Oct. 1, 1884.	Jan. 13, 1898.	*XL*, 5
Filley, Hiel Hamilton	M. Jan. 3, 1883.	May 6, 1907.	......
Fink, Albert	M. July 20, 1870. F. Sept. 3, 1872.	April 3, 1897.	*XLI*, 6
Fisher, Charles Henry	M. June 7, 1869.	Jan. 18, 1888.	XIX,
Fisher, Clark	M. Oct. 19, 1870.	Dec. 31, 1903.	......
Fisher, Elstner	J. April 3, 1889. A. M. June 2, 1897. M. Mar. 5, 1902.	Oct. 12, 1909.	......
Flad, Henry	M. Feb. 15, 1871.	June 20, 1898.	*XLII*, 5
Flint, Edward Austin	M. May 18, 1870.	Jan. 23, 1886.	XII, 1
Flynn, Benjamin Harrison	J. Oct. 2, 1900.	Mar. 1, 1903.	......
Flynn, Patrick John	M. Feb. 4, 1891.	June 1, 1893.	XX,
Fogg, Charles E.	M. Oct. 16, 1872.	April 26, 1891.	XVII, 2
Ford, Arthur Livermore	A. Nov. 6, 1872.	May 30, 1880.	VI,
Forshey, Caleb Goldsmith	M. Aug. 7, 1872.	July 25, 1881.	*XXXVII*, 5
Fowler, Charles Edward	M. May 3, 1876.	Jan. 28, 1883.	XV, 1
Francis, James	M. Jan. 4, 1893.	Dec. 1, 1898.	*XLV*, 6
Francis, James Bicheno	M. Nov. 5, 1852. F. May 4, 1870. H. M. April 5, 1892.	Sept. 18, 1892.	XIX,
Frank, George William	M. Feb. 1, 1899.	Jan. 19, 1905.	......
Franklin, William Buel	M. April 1, 1874.	Mar. 8, 1903.	......
Freeman, Ernest Grey	A.M. May 3, 1893. M. Oct. 5, 1898.	Mar. 6, 1900.	......
Freeman, Frank Leslie	A. Nov. 5, 1895.	Mar. 3, 1907.	......
French, Edmund	M. Nov. 26, 1852.	July 7, 1860.	*XXXVII*, 5
French, Frederick Reginald	M. Sept. 7, 1904.	Nov. 20, 1904.	*LIV*, 5
French, George Harrison	A. M. Dec. 5, 1906.	July 9, 1909.	......
Frost, Benjamin Dix	M. Feb. 21, 1872.	July 19, 1880.	XIII, 1
Fry, Leslie Monroe	J. June 6, 1905. A. M. April 3, 1907.	Nov. 10, 1908.	......
Fteley, Alphonse	M. Jan. 5, 1876.	June 11, 1903.	*LIV*, 5
Fuertes, Estevan Antonio	M. Feb. 17, 1869.	Jan. 16, 1903.	......
Fujino, Shukichi	J. Feb. 3, 1903.	†	......
Gardiner, Edward	M. Nov. 5, 1852.	†	......
Gardner, George Clinton	M. Nov. 3, 1875.	Aug. 12, 1904.	......
Gardner, Henry A.	M. Dec. 13, 1852.	July 26, 1875.	I, 3

---

* The italic references in this column are to the volume and page of *Transactions*, which the Memoirs prepared after January 1st, 1896, were published; the other figur refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than th date will be found.

† Date of death unknown.

Name.	Date of Election.	Date of Death.	Memoirs.*
Garfias, Ignacio	M. Oct. 5, 1892.	Jan. 16, 1898.	....
Gatchell, George Samuel	M. May 7, 1884.	June 22, 1909.	....
Gelette, William Durfree	M. April 1, 1885.	April 27, 1902.	*L, 500*
Giblin, Arthur Leon	J. Jan. 31, 1893.	July 17, 1894.	XX, 171
Gibson, William, Jr.	A. Sept. 5, 1888.	April 19, 1905.	....
Gillespie, Joshua Lathrop	J. Feb. 3, 1875. M. April 2, 1884.	Aug. 22, 1890.	XVI, 224
Gillham, Robert	M. June 2, 1886.	May 19, 1899.	*XLIII, 613*
Gilliss, John Roberts	M. June 2, 1869. F. Mar. 15, 1870.	July 15, 1870.	*XXXVI, 555*
Gillmore, Quincy Adams	M. Dec. 2, 1868.	April 7, 1888.	XX, 60
Gilman, Charles Carroll	F. May 11, 1871.	July 31, 1899.	....
Golay, Philip	M. Sept. 5, 1877.	Oct. 31, 1898.	....
Goodwin, Homer Stanley	M. July 20, 1870.	Dec. 25, 1892.	XIX, 163
Goodwin, John Marston	M. Sept. 4, 1872.	Oct. 21, 1891.	XVII, 267
Gorringe, Henry H.	A. April 6, 1881.	July 6, 1885.	XVI, 215
Gorsuch, Robert Bennett	H. M. Jan. 9, 1905.	June 2, 1906.	....
Gottlieb, Abraham	M. Sept. 4, 1872.	Feb. 9, 1894.	XX, 76
Gould, Edward Sherman	M. Nov. 4, 1885.	Jan. 24, 1905.	*LIV, 528*
Gowen, Charles Sewall	M. Mar. 7, 1888.	Oct. 19, 1909.	....
Graff, Frederic	M. May 7, 1873.	Mar. 30, 1890.	XVII, 247
Graham, Joseph Marshall	M. April 4, 1900.	Feb. 3, 1909.	*LXIV, 583*
Grain, William	M. Sept. 15, 1869.	Jan. 10, 1877.	....
Grant, William Harrison	M. July 2, 1873.	Oct. 12, 1896.	*XXXVI, 557*
Grassau, H.	M. July 6, 1853.	May 16, 1870.	....
Green, Rutger Bleecker	J. May 5, 1896. A. M. Oct. 5, 1898. M. Sept. 6, 1904.	Dec. 8, 1908.	*LXIV, 585*
Greene, Benjamin H.	M. May 1, 1878.	Jan. 4, 1890.	XVI, 187
Greene, Charles Ezra	M. Jan. 4, 1882.	Oct. 17, 1903.	....
Greene, David Maxson	M. May 20, 1868.	Nov. 9, 1905.	*LVI, 466*
Greene, Edward Appleton	M. July 4, 1888.	April 19, 1903.	....
Greene, George Sears	M. Nov. 5, 1852. H. M. Oct. 26, 1888.	Jan. 28, 1899.	*XLIX, 335*
Greene, Joseph Norton	M. Oct. 5, 1887.	July 26, 1904.	*LV, 446*
Greenwood, William Henry	M. Mar. 3, 1880.	Aug. 29, 1880.	VII, 89
Gridley, Vernon Hill	J. Feb. 4, 1896.	Sept. 17, 1896.	*XXXVI, 595*
Griffen, John	M. April 15, 1868.	Jan. 14, 1884.	XII, 38
Griffin, Eugene	M. June 7, 1899.	April 10, 1907.	....
Guild, Josephus Conn	M. June 1, 1898.	Feb. 25, 1907.	*LIX, 540*
Gurnee, Walter S.	F. May 10, 1870.	April 17, 1903.	....
Gzowski, *Sir* Casimir Stanislaus	M. Dec. 2, 1868.	Aug. 24, 1898.	*XLII, 567*

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

DECEASED MEMBERS H

Name.	Date of Election.	Date of Death.	Memoirs
Haddock, Arba Read	A. May 4, 1881.	Feb. 28, 1885.	XIX, 6
Haines, Frank March	M. Mar. 1, 1905.	June 1, 1905.	....
Hall, George Thomas	A. Oct. 2, 1872. M. Sept. 2, 1874.	June 2, 1881.	VII, 9
Hamlin, Charles Edward	A. Jan. 2, 1894.	Jan. 20, 1902.	....
Handy, Edward Adino	M. Jan. 2, 1889.	Nov. 21, 1907.	....
Hannaford, Edmund Phillips	M. Sept. 18, 1872.	Aug. 19, 1902.	....
Harbaugh, Springer	F. May 19, 1871.	Dec. 8, 1887.	XV, 4
Hardee, Thomas Sydenham	M. April 4, 1877.	May 20, 1880.	XII, 6
Harding, Horace	M. Nov. 2, 1892.	July 29, 1899.	*XLIII, 61*
Hardy, George Richardson	M. Nov. 7, 1888.	April 2, 1903.	....
Harper, John Bradford	M. Oct. 4, 1905.	Mar. 24, 1908.	....
Harris, Charles Marshall	A. Jan. 8, 1873.	Oct. 28, 1909.	....
Harris, Henrique	M. Dec. 3, 1873.	Oct. 10, 1882.	*XXXVII, 56*
Harris, Robert Lewis	M. May 3, 1876.	Sept. 29, 1896.	....
Harrison, Stephen A.	F. Jan. 30, 1873.	June 6, 1898.	....
Harrod, Thomas	J. Dec. 3, 1891.	Dec. 31, 1896.	....
Hasell, Bentley Douglas	M. July 3, 1878.	May 29, 1900.	....
Hasie, Montague Sylvester	M. Feb. 3, 1897.	May 30, 1907.	....
Haskell, Charles Frederic Beals	M. Oct. 7, 1891.	May 20, 1895.	XXI, 18
Haslett, Sullivan	M. June 4, 1879.	Jan. 4, 1887.	XIII, 12
Haswell, Charles Haynes	M. Jan. 29, 1868. H. M. May 12, 1905.	May 12, 1907.	*LXI, 5*
Hatfield, Robert G.	M. Dec. 4, 1867.	Feb. 15, 1879.	*XXXVI, 5*
Hausman, Frederick Appel	J. Feb. 3, 1903.	Mar. 6, 1906.	*LVII, 5*
Hawkshaw, *Sir* John	H. M. Nov. 3, 1880.	June 2, 1891.	XVII, 2
Haycroft, James Isaac	A. M. Jan. 3, 1894.	April 11, 1908.	*LXII, 56*
Hayes, Richard Somers	M. Sept. 6, 1882.	Mar. 2, 1905.	*LV, 4*
Hayward, James A.	M. Sept. 5, 1877.	Aug. 13, 1880.	VII, 8
Hegeman, Allen Bogardus	M. Feb. 1, 1888.	Oct. 22, 1892.	XIX, 17
Hemming, Dunkin Wirgman	A. M. Sept. 7, 1892. M. May 31, 1904.	Mar. 22, 1906.	*LIX, 5*
Henry, Daniel Farrand	M. July 7, 1875.	May 13, 1907.	....
Hequembourg, Charles Ezra	M. June 5, 1901.	Oct. 17, 1907.	*LIX, 54*
Hermany, Charles	M. Jan. 6, 1869.	Jan. 18, 1908.	*LXV, 52*
Hildenbrand, Wilhelm	M. Feb. 5, 1902.	Feb. 21, 1908.	....
Hildreth, Russell Wadsworth	J. Jan. 4, 1888.	Dec. 23, 1895.	*XXXVI, 59*
Hilgard, Julius Erasmus	M. July 10, 1872.	May 8, 1891.	XVIII, 18
Hillman, Charles La Fletcher	M. July 5, 1876.	June 14, 1902.	*XLIX, 34*
Hilton, George Porter	M. May 1, 1889.	Oct. 7, 1909.	....
Hislop, John	M. May 1, 1895.	Feb. 22, 1901.	....
Hitt, Smith, Van Dusen	A. M. April 3, 1901.	Aug. 27, 1905.	*LVI, 47*

---

* The italic references in this column are to the volume and page of *Transactions*, i which the Memoirs prepared after January 1st, 1896, were published; the other figure refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than tha date will be found.

Name.	Date of Election.	Date of Death.	Memoirs.*
ortsberg, Maximilian	M. July 10, 1872.	May 16, 1880.	VIII, 118
bby, Arthur Stanley	M. June 6, 1894.	May 28, 1902.	*XLIX, 347*
e, Richard March	M. Oct. 1, 1873.	June 8, 1886.	XVI, 170
lbrook, Henry Randolph	M. Jan. 2, 1890.	Dec. 21, 1907.	....
lley, Alexander Lyman	M. Oct. 1, 1873.	Jan. 29, 1882.	XVI, 212
ran, John Joseph	A. M. Oct. 7, 1908.	Nov. 9, 1909.	....
uston, John	M. May 6, 1868.	Aug. 30, 1896.	*XXXIX, 694*
we, Milton Grosvenor	M. Oct. 16, 1872.	June 19, 1902.	*XLIX, 349*
well, Charles W.	M. Mar. 3, 1875.	April 5, 1882.	VIII, 121
well, George Washington	M. May 2, 1888.	Feb. 15, 1901.	*XLIX, 351*
wland, George, Jr.	F. June 6, 1870.	Feb. 18, 1892.	XX, 154
mphrey, Henry Cyprian	A. M. Sept. 4, 1901. M. Oct. 3, 1905.	Dec. 9, 1909.	....
mphrey, William Sheldon	A. M. Sept. 2, 1891.	April 18, 1895.	XXI, 98
mphreys, Andrew Atkinson	H. M. May 7, 1873.	Dec. 27, 1883.	XVI, 218
mphreys, Charles	M. Feb. 1, 1905.	Nov. 18, 1906.	*LVIII, 534*
nt, Alfred Ephraim	M. Sept. 1, 1886.	April 26, 1899.	*XLVI, 557*
nt, Randell	M. May 2, 1883.	Jan. 24, 1898.	*XLV, 629*
ntington, Collis Potter	F. Mar. 10, 1877.	Aug. 13, 1900.	....
tton, Nathaniel Henry	M. June 3, 1896.	May 8, 1907.	*LX, 581*
tton, William Rich	M. Jan. 8, 1873.	Dec. 11, 1901.	....
de, William B.	M. July 12, 1877.	June 8, 1882.	XVI, 172
s, Edward Bernard	M. April 5, 1893.	Dec. 30, 1903.	....
ckson, Jones Mumford	M. Sept. 1, 1886.	Aug. 31, 1906.	....
mes, John Collinson	M. Mar. 1, 1876.	Feb. 27, 1883.	XVI, 164
nnings, Henry Clay	M. April 6, 1887.	Mar. 13, 1894.	XX, 88
nnings, William Tyndale	M. April 2, 1884.	Oct. 24, 1906.	....
rvis, John Bloomfield	M. Dec. 4, 1867. H. M. Dec. 2, 1868. F. Mar. 19, 1880.	Jan. 12, 1885.	XI, 109
ewett, William Bradford	J. June 4, 1891.	Nov. 7, 1894.	XX, 202
hnson, Archibald	M. April 6, 1898.	Oct. 3, 1899.	....
hnson, Charles Roberts	M. June 3, 1885.	Sept. 11, 1893.	XX, 45
hnson, John Butler	M. April 7, 1886.	June 23, 1902.	*LI, 454*
hnson, Lorenzo Medici	J. Mar. 3, 1875. M. April 7, 1880.	Nov. 28, 1904.	....
hnson, T. Marr	M. Feb. 26, 1872.	July 31, 1874.	I, 171
hnson, Wallace Clyde	M. Oct. 5, 1892.	Dec. 15, 1906.	*LVIII, 538*
hnston, Andrew Langstaff	M. June 4, 1890.	May 15, 1901.	....
nes, Benjamin Franklin	F. June 13, 1870.	May 19, 1903.	....

---

* The italic references in this column are to the volume and page of *Transactions*, in hich the Memoirs prepared after January 1st, 1896, were published; the other figures fer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that te will be found.

Name.	Date of Election.	Date of Death.	Memoir
Jordan, Gabriel	M. Sept. 18, 1872.	Nov. 10, 1884.	XVI, 1
Joy, James Frederic	F. Nov. 6, 1872.	Sept. 24, 1896.	*XXXVII, 5*
Judah, Theodore Dehone	M. May 4, 1853.	Nov. 2, 1863.	*XXXVIII, 4*
Keefer, Samuel	M. Jan. 6, 1869.	Jan. 9, 1890.	XVI, 2
Kenyon, George Cecil	A. M. April 4, 1900. M. June 6, 1905.	Oct. 30, 1906.	......
Kernot, William Charles	M. Mar. 6, 1889.	Mar. 14, 1909.	....
Killebrew, Samuel	M. Sept. 2, 1885.	Jan. 9, 1899.	*XLI, 6*
Kingsley, William C.	F. June 6, 1870.	Feb. 21, 1885.	*XXXVI, 6*
Kinney, Edward Cornelius	M. May 3, 1882.	Jan. 16, 1910.	....
Kirkwood, James Pugh	M. Nov. 5, 1852.	April 22, 1877.	IV,
Kloman, Andrew	F. Jan. 27, 1875.	Dec. 19, 1880.	VII, 1
Knight, William Baker	J. Jan. 6, 1875. M. Jan. 7, 1880.	Dec. 7, 1890.	XVII, 2
Knowlton, Charles Andrews	M. Oct. 2, 1901.	Mar. 2, 1903.	*LV, 4*
Krupp, Alfred	F. June 14, 1870.	July 14, 1887.	*XXXVI, 6*
Lane, Moses	M. Dec. 4, 1867.	Jan. 25, 1882.	XIX, 58, 1
Lassig, Moritz	M. April 2, 1884.	Jan. 7, 1902.	*XLIX, 3*
Latcha, Jacob Albert	M. May 7, 1873.	Nov. 30, 1904.	*LIV, 5*
Latham, Norman Smith	J. July 3, 1889.	Nov. 10, 1903.	*LIV, 5*
Latimer, Charles	M. April 5, 1876.	Mar. 25, 1888.	XV, 1
Latrobe, Charles Hazlehurst	M. Nov. 16, 1870.	Sept. 19, 1902.	......
Laurie, James	M. Nov. 5, 1852.	Mar. 16, 1875.	*XXXVII, 5*
Lavalle, Louis Ralph	A. M. Feb. 1, 1905.	Nov. 15, 1905.	......
Law, Arthur Price	A. M. June 3, 1903.	Nov. 19, 1906.	*LVIII, 5*
Lawler, John	F. April 28, 1883.	Feb. 23, 1891.	......
Lawson, William Bateman	M. Feb. 1, 1893.	Jan. 27, 1901.	*XLVI, 5*
Lawton, Frederick Beecher	J. Nov. 5, 1891. A. M. Nov. 4, 1896.	Oct. 13, 1897.	......
Lederle, George Anthony	J. May 2, 1883. M. Oct. 6, 1886.	Mar. 27, 1905.	....
Leers, Frank Adolph	M. May 4, 1887.	May 19, 1890.	XX,
Lesage, Louis	M. Sept. 7, 1881.	Jan. 9, 1889.	XVI,
Leutzé, Trevor McClurg	M. Feb. 3, 1897.	Oct. 14, 1901.	......
Leverich, Gabriel	M. July 6, 1870.	Nov. 28, 1905.	*LVI, 4*
Lewis, Isaiah William Penn	M. Jan. 5, 1853.	Oct. 18, 1856.	*XXXVIII, 4*
Lewis, James Frederick	A. Feb. 6, 1889.	July 23, 1901.	....
Libby, Edmund Dorman	M. May 6, 1885.	April 24, 1903.	....
Lincoln, William Shattuck	M. Dec. 5, 1883.	May 16, 1902.	*LI, 45*
Lindenberger, Cassius Howard	A. Feb. 2, 1892.	Jan. 5, 1905.	....
Lindenthal, Dominik	A. M. Mar. 4, 1896.	June 7, 1900.	*XLV, 6*

---

* The italic references in this column are to the volume and page of *Transactions*, i which the Memoirs prepared after January 1st, 1896, were published; the other figure refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than tha date will be found.

Name.	Date of Election.	Date of Death.	Memoirs.*
LINVILLE, JACOB HAYS	M. Mar. 3, 1875.	Aug. 4, 1906.	*LIX, 549*
LOCKE, AUGUSTUS WOODBURY	M. June 7, 1882.	May 14, 1893.	XIX, 172
LOCKWOOD, JOHN	A. April 5, 1882.	Dec. 9, 1891.	XVIII, 192
LONG, DENNIS	F. Mar. 28, 1872.	Oct. 8, 1893.	....
LONG, THOMAS JOHN	J. Nov. 3, 1875. M. Jan. 7, 1880.	Nov. 20, 1905.	....
LOOKER, HENRY BRIGHAM	A. M. May 3, 1893.	Jan. 3, 1905.	*LVIII, 548*
LOTZ, WILLIAM HERMAN	M. Sept. 1, 1875.	Jan. 31, 1894.	XX, 74
LOVECRAFT, FREDERICK AARON	F. Nov. 1, 1892.	Oct. 26, 1893.	....
LOVETT, THOMAS DAVIS	M. May 3, 1871.	Dec. 5. 1897.	*XL, 571*
LOWE, GORHAM PARSONS	M. April 21, 1869.	Jan. 8, 1894.	XX, 72
LOWTHORP, FRANCIS C.	M. April 1, 1868. F. Mar. 17, 1870.	June 1, 1890.	XX, 196
LUDLOW, WILLIAM	M. July 5, 1882.	Aug. 30, 1901.	....
LUSK, JAMES LORING	M. Mar. 4, 1891.	Sept. 25, 1906.	....
LYON, WILLIAM M.	F. Mar. 23, 1870.	July 3, 1889.	XVI, 112
LYTE, FRANCIS ASBURY	A. M. Oct. 5, 1892.	June 24, 1896.	*XXXVIII, 461*
MACLENNAN, JOHN DONALD	M. Oct. 4, 1899.	Feb. 26, 1907.	....
MACLEOD, JOHN	M. July 10, 1872.	Jan. 21, 1900.	....
MACNAUGHTON, JAMES	M. May 5, 1880.	Dec. 29. 1905.	*LVI, 471*
MACRITCHIE, CHARLES	A. Oct. 2, 1872. M. April 5, 1876.	Jan. 27. 1909.	*LXIV, 587*
MACY, ARTHUR	J. July 12, 1877. M. Dec. 2, 1885.	April 14, 1891.	*XXXVII, 562*
MCALPINE, CHARLES LEGRAND	M. Dec. 4, 1867.	Jan. 11, 1884.	*XXXVII, 563*
MCALPINE, WILLIAM JARVIS	M. Feb. 3, 1853. H. M. Oct. 26, 1888.	Feb. 16, 1890.	XVIII, 115
MCCALLA, RICHARD CALVIN	J. July 2, 1890. A. M. Sept. 2, 1891. M. Dec. 5, 1894.	June 13, 1904.	*LV, 453*
MCCURDY, JOHN EGBERT	M. April 1, 1896.	Dec. 15, 1908.	....
MCGEE, VAN NORMAN	A. M. June 6, 1900.	Sept. 28, 1904.	*LIV, 538*
MCKEAN, REGINALD	A. M. May 2, 1894.	Oct. 15, 1901.	*XLIX, 366*
MCKEOWN, THOMAS	M. Dec. 3, 1879.	June 7, 1904.	....
MCNAIR, THOMAS SPEER	M. July 2, 1873.	July 25. 1901.	....
MAHAN, DENNIS HART	H. M. Mar. 2, 1853.	Sept. 16. 1871.	XIX, 161
MALÉZIEUX, EMILE	H. M. Nov. 3, 1880.	May 20, 1885.	*XXXVI, 524*
MANN, GEORGE EDWARD	M. Sept. 3, 1884.	Oct. 2, 1897.	....
MANSFIELD, MARTIN WILLIAM	M. July 5, 1882.	Sept. 25, 1908.	*LXIII, 431*
MARINDIN, HENRY LOUIS	M. May 7, 1884.	Mar. 25, 1904.	....
MARR, GEORGE ANSON	M. Oct. 3, 1883.	Mar. 24, 1905.	*LV, 454*
MARSHALL, CHARLES ALFRED	M. Oct. 1, 1884.	May 31, 1889.	XVI, 99

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

DECEASED MEMBERS M

Name.	Date of Election.	Date of Death.	Memoirs.
Marsland, Edward	M. Feb. 6, 1878.	June 25, 1898.	....
Martin, Charles Cyril	M. July 10, 1872.	July 11, 1903.	....
Martin, Robert Kirkwood	M. June 1, 1892.	Nov. 24, 1893.	XX, 4
Mason, Eddy D.	M. July 19, 1872. F. Dec. 28, 1872.	Dec. 19, 1874.	I, 32
Mayer, August	A. M. June 1, 1892.	Mar. 25, 1909.	....
Mendell, George Henry	M. Sept. 6, 1876.	Oct. 19, 1902.	*LI, 45*
Menocal, Aniceto G.	M. Feb. 3, 1875.	July 20, 1908.	....
Mercur, Frederick	M. July 20, 1870.	Jan. 17, 1888.	XVII, 15
Meriwether, Niles	M. Nov. 1, 1871.	Dec. 28, 1900.	*XLV, 63*
Merrill, William Emery	M. Oct. 6, 1872.	Dec. 14, 1891.	XVIII, 9
Merz, Frederick W.	F. May 28, 1872.	Dec. 8, 1883.	*XXXVI, 61*
Metcalf, William	M. July 2, 1873.	Dec. 5, 1909.	....
Meyer, Thomas C.	M. Dec. 7, 1852.	Jan. 26, 1908	....
Michaelis, Otho Ernest	M. May 6, 1874.	May 1, 1890.	XVII, 13
Michie, William Roberts	J. Feb. 28, 1893. A. M. Oct. 7, 1896.	Feb. 2, 1899.	*XLI, 64*
Miller, Alexander Macomb	M. June 6, 1888.	Sept. 14, 1904.	....
Miller, Samuel H.	M. Sept. 6, 1882.	Mar. 18, 1891.	XVII, 20
Miller, Silvanus, Jr.	M. Mar. 2, 1887.	Dec. 17, 1897.	*XXXIX, 69*
Mills, James Ellison	M. Feb. 3, 1886.	July 25, 1901.	....
Milne, Peter	A. Jan. 7, 1896.	June 9, 1902.	....
Minturn, Rowland Robinson	M. Nov. 2, 1887.	April 7, 1898.	....
Mitchell, Alexander	F. June 13, 1883.	April 19, 1887.	XIII, 9
Mitchell, Henry	M. Jan. 7, 1880.	Dec. 1, 1902.	....
Mitchell, Stephen Arnold	M. Oct. 2, 1907.	May 21, 1908.	*LXII, 55*
Moffet, James David	A. M. Nov. 4, 1891. M. Feb. 7, 1894.	Nov. 3, 1899.	....
Monroe, John Albert	M. Sept. 4, 1869.	June 11, 1891.	XIX, 14
Montony, Liberty Gilbert	J. May 3, 1892. A. M. Feb. 5, 1896.	Oct. 20, 1909.	....
Morison, George Shattuck	M. Jan. 6, 1875.	July 1, 1903.	*LIV, 51*
Morison, William Smith	A. M. April 6, 1904.	May 1, 1905.	....
Morley, James Henry	M. Oct. 6, 1886.	Sept. 8, 1889.	XVI, 11
Morley, William Raymond	M. Sept. 6, 1882.	Jan. 3, 1883.	IX, 12
Morrell, William H.	M. Nov. 5, 1852.	†	....
Morris, Gouverneur	M. Oct. 3, 1888.	Dec. 30, 1897.	*XXXIX, 69*
Morris, Robert Campbell	M. Jan. 7, 1874.	Nov. 8, 1892.	XVIII, 22
Morris, William W.	M. Jan. 5, 1853.	†	....
Morse, Henry Grant	M. April 7, 1880.	June 2, 1903.	....
Morse, James Otis	M. Feb. 9, 1853.	Mar. 8, 1883.	XIX, 47
Morton, Charles	M. Oct. 2, 1895.	Aug. 28, 1909.	....

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

† Date of death unknown.

Name.	Date of Election.	Date of Death.	Memoirs.*
Morton, John Henry	M. June 3, 1891.	Feb. 8, 1892.	XVIII, 105
Moulton, Mace	M. June 4, 1884.	April 27, 1909.	....
Murakami, Kyoichi	M. Sept. 4, 1901.	Aug. 18, 1906.	....
Murdoch, Gilbert	M. Sept. 7, 1881.	May 28, 1894.	XX, 152
Myers, Edmund Trowbridge Dana	M. May 2, 1888.	May 12, 1905.	....
Myers-Beswick, William Beswick	M. Jan. 3, 1894.	Dec. 27, 1904.	*LIV, 534*
Neilson, Robert	M. Feb. 17, 1869.	Oct. 12, 1896.	*XXXVII, 564*
Nelles, George Thomas	M. Oct. 3, 1888.	Nov. 15, 1907.	*LX, 586*
Newell, John	M. Jan. 29, 1868.	Aug. 26, 1894.	XX, 172
Newham, Charles Edward	M. Dec. 7, 1887.	Feb. 1, 1898.	....
Newton, Isaac	M. Mar. 3, 1880.	Sept. 25, 1884.	XI, 128
Newton, John	H. M. April 30, 1884.	May 1, 1895.	....
Nichols, Norman James	M. Dec. 5, 1888.	April 8, 1896.	*XXXVI, 559*
Nichols, Othniel Foster	M. June 7, 1876.	Feb. 4, 1908.	*LXI, 564*
Nicholson, George Benson	M. May 1, 1878.	Dec. 2, 1906.	*LIX, 556*
Nickerson, Louis H.	M. Sept. 18, 1872.	May 6, 1877.	....
Norman, George H.	M. Feb. 17, 1869. F. Mar. 23, 1870.	Feb. 4, 1900.	....
Northrup, Herbert Franklin	M. Jan. 6, 1892.	Jan. 21, 1908.	*LX, 588*
Norton, Frederick Oakford	F. June 4, 1879.	Sept. 27, 1892.	XVIII, 219
Norton, John Talcott	M. Nov. 3, 1897.	Aug. 5, 1905.	....
Nourse, Edwin Green	M. Sept. 3, 1884.	Dec. 8, 1897.	*XXXIX, 699*
Noyes, Albert Franklin	M. Dec. 3, 1884.	Oct. 12, 1896.	*XXXVI, 560*
Oberndorf, Paul Ernest	J. Feb. 5, 1907.	Oct. 13, 1907.	*LX, 595*
Ogden, William B.	F. Mar. 23, 1870.	Aug. 3, 1877.	IV, 67
Olney, Robert Blum	J. Jan. 3, 1895. A. M. Sept. 5, 1900.	Mar. 4, 1903.	*L, 510*
O'Melveny, John Charles	M. May 4, 1898.	Oct. 3, 1899.	....
O'Sullivan, Thomas S.	M. Jan. 5, 1853.	Nov. 1, 1855.	....
Paddock, Joseph Hill	M. Oct. 5, 1892.	April 4, 1894.	XX, 89
Paine, Charles	M. Dec. 4, 1867.	July 4, 1906.	*LX, 575*
Paine, William H.	M. May 12, 1875.	Dec. 31, 1890.	XVII, 160
Palmer, Cornelius	M. Nov. 2, 1887.	July 31, 1903.	....
Parker, Charles Francis	J. Mar. 5, 1890.	Oct. 10, 1898.	....
Parker, William	M. Mar. 7, 1900.	Sept. 30, 1909.	....
Parkhurst, Henry Williams	M. Sept. 5, 1877.	April 7, 1906.	....
Patterson, John Austin	M. May 2, 1900.	May 3, 1903.	....

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

DECEASED MEMBERS P-R

Name.	Date of Election.	Date of Death	Memoirs
PEARSON, WILLIAM ANSON, JR.	M. Sept. 6, 1905.	May 26, 1908	....
PEARSONS, GALEN W.	M. Jan. 6, 1875.	Aug. 19, 1907.	....
PENNYPACKER, LEVIS PASSMORE	A. M. April 1, 1891.	Jan. 30, 1901.	*XLVI, 57*
PERRINE, FREDERIC AUTEN COMBS	M. May 3, 1905.	Oct. 20, 1908.	....
PETRY, ALFRED	M. Oct. 6, 1886.	May 14, 1901.	....
PHILBRICK, EDWARD SOUTHWICK	M. May 6, 1874.	Feb. 13, 1889.	*XXXVIII, 45*
PHILLIPS, WILLIAM	F. Mar. 23, 1870.	April 14, 1874.	I, 16
PHINNEY, HENRY WARD BEECHER	M. Jan. 7, 1885.	Nov. 22, 1888.	*XXXVI, 56*
PIERCE, WILLIAM THOMAS	M. May 6, 1896.	Feb. 26, 1906.	*LVII, 52*
PIKE, WILLIAM ABBOT	M. Dec. 3, 1890.	Oct. 13, 1895.	XXI, 21
PLATT, JOSEPH CURTIS	M. July 2, 1895.	July 7, 1898.	....
PLYMPTON, GEORGE WASHINGTON	M. Jan. 29, 1868.	Sept. 11, 1907.	....
POE, ORLANDO M.	M. Jan. 8, 1873.	Oct. 2, 1895.	....
POINIER, P. PORTER	J. Mar. 3, 1875.	June 11, 1876.	IV, 7
POPE, MACY STANTON	A. M. May 2, 1900.	Dec. 10, 1904.	*LIV, 54*
POPE, WILLARD SMITH	M. Aug. 7, 1872.	Oct. 10, 1895.	*XXXVI, 56*
PORTER, ALBERT HOWELL	J. July 4, 1888. A. M. July 1, 1891.	Aug. 9, 1899.	....
POST, ANDREW JACKSON	M. Nov. 1, 1871.	Mar. 12, 1896.	....
POST, JAMES CLARENCE	M. Feb. 6, 1878.	Jan. 6, 1896.	*XXXVI, 56*
POST, SIMEON S.	M. Nov. 5, 1852.	June 29, 1872.	XIX, 4
POTTS, JOSEPH DILWYN	M. Aug. 5, 1868.	Dec. 3, 1893.	XX, 4
POTTS, RICHARD	M. June 1, 1870.	July 11, 1891.	XVII, 24
POWELL, CHARLES FRANCIS	M. Oct. 3, 1888.	July 30, 1907.	*LXI, 56*
POYNOR, DAVID ASHLEY	M. June 1, 1892.	May 29, 1906.	....
PRATT, THOMAS WILLIS	M. Nov. 2, 1853. F. Nov. 4, 1870.	July 17, 1875.	I, 33
PRATT, WILLIAM ARTHUR	M. Dec. 4, 1895.	Sept. 19, 1904.	....
PRENDERGAST, FRANCIS ENSOR	M. Mar. 7, 1888.	Dec. 7, 1897.	*XXXIX, 70*
PREVOST, SUTHERLAND MALLET	M. Jan. 6, 1875.	Sept. 30, 1905.	....
PRICE, PHILIP M.	M. May 2, 1888.	Oct. 4, 1894.	XX, 20
PRINCE, EDWARD	J. Feb. 6, 1878. M. Nov. 1, 1882.	Dec. 12, 1908.	....
PROBASCO, SAMUEL R.	M. Nov. 18, 1868.	Jan. 19, 1910.	....
PROSSER, THOMAS	M. Dec. 4, 1867.	Sept. 15, 1870.	*XXXVI, 56*
PROSSER, THOMAS	F. June 1, 1870.	Jan. 6, 1896.	....
PUTNAM, JOSEPH W.	A. Mar. 3, 1880.	Mar. 24, 1893.	XX, 8
QUINETTE DE ROCHEMONT, *Baron* EMILE THEODORE	M. Jan. 3, 1894.	Dec. 8, 1908.	....
QUINLAN, GEORGE AUSTIN	M. Oct. 4, 1893.	Aug. 29, 1901.	....
RAFTER, GEORGE W.	M. April 2, 1884.	Dec. 29, 1907.	*LXII, 55*

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

Name.	Date of Election.	Date of Death.	Memoirs.*
andolph, James Lingan	M. Mar. 1, 1882.	Sept. 17, 1888.	XVIII, 217
aymond, Thomas Laidlaw	M. Oct. 6, 1897.	Nov. 15, 1901.	*XLIX, 354*
eece, Benjamin	M. Mar. 2, 1881.	Dec. 17, 1901.	....
eed, Edward M.	M. July 10, 1872.	Feb. 13, 1892.	XVIII, 94
eed, Henry Wadsworth	M. Jan. 6, 1886.	Oct. 26, 1900.	....
eed, Samuel Benedict	M. Oct. 20, 1869.	Dec. 25, 1891.	XVIII, 183
eed, William Ward	F. Dec. 20, 1872.	Jan. 10, 1904.	*LII, 558*
ees, William Marshall	M. Oct. 4, 1905.	Dec. 4, 1905.	*LVI, 473*
eeves, Samuel J.	M. April 5, 1868.	Dec. 15, 1878.	V, 93
einholdt, Kenneth Oake Plummer	J. Feb. 6, 1894. A. M. Oct. 7, 1896.	Feb. 6, 1902.	*XLIX, 368*
eiseger, Marc John	M. Dec. 7, 1898.	May 26, 1900.	*XLV, 634*
eno, James Hart	M. Nov. 5, 1879.	Aug. 5, 1881.	*XXXVII, 566*
hodes, Benjamin	M. April 5, 1882.	Aug. 12, 1894.	XX, 163
hys-Roberts, Edmund Alyth	A. M. Nov. 3, 1897.	Oct. 5, 1909.	....
ice, Edward Curtis	M. April 7, 1875.	April 21, 1898.	*XXXIX, 703*
ice, Lewis Frederick	M. Jan. 2, 1889.	April 13, 1909.	....
ich, Watson Wellman	M. Sept. 5, 1883.	Jan. 12, 1903.	*L, 501*
ichards, Joseph Ruggles	A. Feb. 4, 1880.	Sept. 28, 1900.	*XLV, 640*
ichardson, B. Frank	M. July 1, 1885.	April 18, 1904.	....
ichardson, Henry Brown	M. May 7, 1879.	Aug. 21, 1909.	....
iffle, Albert Stanley	M. May 7, 1890.	Oct. 28, 1909.	....
inecker, Francis	M. Aug. 7, 1872.	April 10, 1899.	*XLII, 569*
ives, Alfred L.	M. Sept. 4, 1872.	Feb. 27, 1903.	....
oberts, William	A. June 4, 1884.	Dec. 28, 1907.	*LX, 593*
oberts, William Milnor	M. Sept. 21, 1870.	July 14, 1881.	*XXXVI, 531*
obinson, George Henry	M. Mar. 7, 1888.	July 4, 1906.	....
obinson, Moncure	H. M. July 6, 1853.	Nov. 10, 1891.	XVIII, 84
oebling, John Augustus	M. Dec. 2, 1868.	July 22, 1869.	....
ogers, Albert Brainerd	M. June 6, 1883.	May 4, 1889.	XVI, 98
ogers, Fairman	M. May 7, 1873.	Aug. 22, 1900.	....
ogers, John Benjamin	M. Aug. 4, 1873.	April 1, 1874.	I, 168
ogers, Merritt Harrison	M. Jan. 2, 1890.	May 3, 1907.	*LIX, 562*
ohnert, Benno	J. April 3, 1889.	Sept. 1, 1906.	*LVIII, 557*
osecrans, William Starke	M. July 5, 1882.	Mar. 11, 1898.	....
osenzweig, Alfred	J. June 7, 1882. M. Jan. 4, 1893.	Jan. 13, 1904.	....
osewater, Andrew	M. Oct. 3, 1883.	April 17, 1909.	....
othwell, Richard Pennefather	M. Jan. 29, 1868.	April 17, 1901.	....
owe, Robert Delos	M. Jan. 2, 1890.	Mar. 14, 1899.	*XLII, 571*
owland, Thomas Fitch	M. Dec. 4, 1867. H. M. Dec. 20, 1899.	Dec. 13, 1907.	*LXII, 547*
udolff, Henry Frederick	M. Jan. 6, 1886.	June 1, 1895.	*XXXVI, 570*

---

* The italic references in this column are to the volume and page of *Transactions*, in vhich the Memoirs prepared after January 1st, 1896, were published; the other figures efer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that late will be found.

DECEASED MEMBERS R-S

Name.	Date of Election.	Date of Death.	Memoi
RUMSEY, B. C.	F. May 12, 1870.	†	......
RUSLING, GEORGE McCRACKEN	M. Nov. 1, 1882.	Feb. 26, 1901.	......
RUSSELL, NATHANIEL EDWARDS	M. Oct. 3, 1888.	Jan. 14, 1902.	*XLIX,* 9
ST. JOHN, ISAAC MUNROE	M. July 14, 1871.	April 7, 1880.	*XXXVI,* 5
SANDERSON, JAMES GARDNER	M. July 6, 1881.	Nov. 15, 1909.	......
SCHAUB, JULIUS WILLIAM	J. Nov. 5, 1884. M. Oct. 6, 1886.	Mar. 30, 1909.	......
SCHERMERHORN, LOUIS YOUNGLOVE	M. May 5, 1897.	April 3, 1908.	......
SCHERZER, WILLIAM	M. Sept. 5, 1888.	July 20, 1893.	XX,
SCHOFIELD, MARK WILLIAM	M. May 1, 1907.	Nov. 27, 1908.	*LXIII,* 4
SCHOTT, CHARLES RIDGELY	M. April 1, 1874.	July 9, 1878.	IV, 1
SCHUYLER, HOWARD	M. June 7, 1882.	Dec. 3, 1883.	*XXXVI,* 5
SCOTT, WILLIAM LAWRENCE	F. July 7, 1870.	Sept. 19, 1891.	XVII, 2
SCOTT, WILLIAM ULYSSES	A. M. Feb. 3, 1897.	Sept. 26, 1898.	*XLII,* 5
SCOWDEN, THEODORE RANSOM	M. May 7, 1873.	Dec. 31, 1881.	......
SEATON, WILLIAM, JR.	A. M. June 4, 1902.	Jan. 18, 1908.	......
SEELY, THOMAS JENNINGS	M. Feb. 1, 1882.	Oct. 2, 1883.	*XXXVI,* 5
SEITZINGER, WILLIAM WHITE	J. Oct. 2, 1889.	Sept. 21, 1900.	......
SELLERS, COLEMAN	M. May 3, 1876.	Dec. 28, 1907.	......
SEYMOUR, HORATIO	A. Jan. 8, 1873. M. April 7, 1880.	Feb. 21, 1907.	......
SEYMOUR, MARK TUCKER	F. July 21, 1870.	May 30, 1885.	*XXXVII,* 5
SHALER, IRA ALEXANDER	J. July 4, 1888. M. June 5, 1895.	June 29, 1902.	*XLIX,* 3
SHANKS, THOMAS PEARMAN	M. May 2, 1888.	Jan. 7, 1904.	......
SHELDON, SIMEON	M. Feb. 5, 1873.	Mar. 4, 1883.	......
SHINBUR, ELVER LA ZELLE	A. M. Oct. 3, 1906.	Nov. 7, 1906.	*LVII,* 5
SHINN, WILLIAM POWELL	M. Sept. 15, 1869.	May 5, 1892.	XVIII, 1
SHIRREFFS, REUBEN	M. June 4, 1890.	Aug. 31, 1904.	......
SHREVE, SAMUEL HENRY	M. May 19, 1869.	Nov. 27, 1884.	*XXXVI,* 5
SICARD, MIRTILIANO	M. Jan. 4, 1882.	Mar. 17, 1896.	*XL,* 5
SICKELS, FREDERICK ELLSWORTH	M. Jan. 7, 1891.	Mar. 9, 1895.	*XXXVI,* 5
SICKELS, THEOPHILUS E.	M. Feb. 21, 1872.	Feb. 4, 1885.	XI, 1
SIDELL, WILLIAM H.	M. Dec. 1, 1852.	July 1, 1873.	I,
SITES, WILMON W. C.	M. Nov. 6, 1878.	Oct. 1, 1885.	*XXXVI,* 5
SLATAPER, FELICIAN	M. Sept. 15, 1869.	Sept. 11, 1906.	*LVIII,* 5
SLEEPER, GEORGE EDWARD	M. Feb. 3, 1904.	Oct. 25, 1908.	......
SLOAN, ROBERT IMLAY	M. Oct. 1, 1884.	May 3, 1901.	*XLVI,* 5
SMEDLEY, SAMUEL LIGHTFOOT	M. Sept. 2, 1874.	July 21, 1894.	XXI,
SMITH, BENJAMIN BURGH	M. Nov. 7, 1888.	Feb. 8, 1904.	*LII,* 5
SMITH, CHARLES AUGUSTUS	M. April 7, 1880.	Feb. 2, 1884.	XI, 1
SMITH, CHARLES C.	M. July 10, 1872.	April 17, 1889.	XV, 1

---

* The italic references in this column are to the volume and page of *Transactions,* which the Memoirs prepared after January 1st, 1896, were published; the other figur refer to the volume and page of *Proceedings,* where the Memoirs prepared earlier than th date will be found.

† Date of death unknown.

Name.	Date of Election.	Date of Death.	Memoirs.*
Smith, Charles Shaler	M. Mar. 5, 1873.	Dec. 19, 1886.	XIII, 105
Smith, Charles Vandervoort	M. July 5, 1876.	June 30, 1884.	XI, 126
Smith, David Lowber	M. May 4, 1887.	Oct. 10, 1893.	XX, 57
Smith, Frederick Henry	M. Feb. 21, 1872.	Dec. 24, 1898.	*XLI, 643*
Smith, Hamilton	M. Feb. 5, 1879.	July 4, 1900.	*XLVI, 564*
Smith, Isaac Williams	M. Oct. 1, 1873.	Jan. 1, 1897.	*XXXVIII, 456*
Smith, Lucius A.	M. May 7, 1873.	Jan. 5, 1894.	XX, 48
Snyder, Francis Edward	M. Sept. 6, 1905.	Dec. 23, 1905.	....
Sosa, Pedro José	M. Dec. 3, 1884.	July 4, 1898.	....
Spalding, Ira	M. Aug. 2, 1870.	Oct. 2, 1875.	I, 338
Spencer, Samuel	M. Sept. 2, 1885.	Nov. 29, 1906.	....
Spielmann, Arthur	A. Mar. 5, 1873. M. Sept. 5, 1877.	Nov. 29, 1883.	X, 115
Spier, Charles Louis	A. May 3, 1905.	May 7, 1906.	....
Spörck, Karl	M. Mar. 2, 1898.	June 23, 1899.	....
Stahlberg, Albert Jacob	J. Mar. 4, 1874.	Aug. 19, 1887.	*XXXVI, 597*
Stanwood, James Hugh	A. M. Oct. 3, 1894.	May 24, 1896.	*XXXVI, 590*
Starling, William	M. Sept. 7, 1887.	Dec. 11, 1900.	*XLVI, 566*
Starr, William Wright	M. May 1, 1907.	†	....
Steele, Henry Maynadier	A. M. April 5, 1893. M. Dec. 6, 1899.	July 5, 1909.	....
Stewart, Herbert	A. Feb. 6, 1894.	Mar. 4, 1899.	....
Stewart, David A.	F. Nov. 7, 1872.	Dec. 14, 1888.	XIX, 160
Stites, Archer Cochran	J. Dec. 3, 1890. A. M. Nov. 4, 1891. M. May 6, 1896.	Aug. 27, 1905.	*LVI, 475*
Stixrud, Martinius	M. April 3, 1889.	Dec. 28, 1901.	*LI, 463*
Stone, Waterman	A. Dec. 1, 1886.	Mar. 30, 1896.	*XLI, 649*
Storrow, Charles Storer	H. M. Jan. 24, 1893.	April 30, 1904.	....
Stratton, Franklin Asa	M. May 3, 1876.	July 17, 1879.	V, 96
Stratton, George Draper	A. M. Oct. 4, 1899.	Nov. 21, 1905.	*LVI, 481*
Striedinger, Julius Hermann	M. Feb. 2, 1876.	Sept. 28, 1894.	XX, 198
Swan, Charles Herbert	M. Mar. 16, 1870.	April 17, 1899.	*XLVI, 568*
Sweet, Elnathan	M. Nov. 6, 1878.	Jan. 27, 1903.	....
Swift, McRee	M. Nov. 6, 1852. F. Mar. 9, 1870.	April 5, 1896.	*XXXVI, 616*
Taintor, William Noyes	J. Sept. 3, 1895.	April 8, 1898.	*XXXIX, 704*
Talcott, Cook	M. April 15, 1868.	Jan. 12, 1893.	XIX, 99
Talcott, William Hubbard	M. Feb. 2, 1853.	Dec. 8, 1868.	XIX, 97
Tallon, John Joseph	J. Sept. 3, 1890.	May ‡ 1896.	....

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

† Date of death unknown.

‡ Exact date of death unknown.

DECEASED MEMBERS T-V

Name.	Date of Election.	Date of Death.	Memoirs.
Tasker, Charles A.	J. Nov. 4, 1874.	Oct. 4, 1879.	VII, 9
Tasker, Stephen Paschall Morris	F. Sept. 20, 1872.	Mar. 19, 1900.	*XLVI, 57*
Tasker, Thomas T., Jr.	F. Jan. 7, 1873.	Aug. 19, 1877.	....
Tatnall, George	M. May 3, 1899.	Sept. 13, 1906.	*LVIII, 54*
Taylor, Selwyn Mellon	M. Oct. 7, 1903.	Jan. 25, 1904.	*LII, 55*
Taylor, William Johnston	F. May 10, 1870.	Feb. 17, 1903.	....
Temple, John Frederic	J. Feb. 5, 1890. A. M. Oct. 4, 1893.	July 21, 1895.	XXI, 18
Temple, Robert Henry	M. May 6, 1885.	Dec. 23, 1901.	....
Terry, Edward Clinton	M. Feb. 6, 1895.	April 6, 1908.	....
Thaw, William	F. Aug. 30, 1871.	Aug. 17, 1889.	XVI, 10
Thayer, William Watmough	A. M. Dec. 2, 1891.	Mar. 14, 1893.	XIX, 9
Thomas, Arthur Towne	M. June 6, 1894.	Oct. 10, 1900.	*XLIX, 36*
Thomas, George Edward	M. Oct. 5, 1898.	Mar. 6, 1908.	*LXI, 57*
Thomas, Joseph Russell	M. Oct. 5, 1881.	Nov. 28, 1896.	*XXXVII, 56*
Thompson, John Chambers	M. May 18, 1870.	Jan. 17, 1880.	*XXXVI, 58*
Thompson, William George McNeill	M. July 2, 1879.	May 12, 1903.	....
Thomson, George Huntington	M. Feb. 2, 1887.	Feb. 7, 1910.	....
Thorndike, John Larkin	M. May 7, 1873.	Oct. 12, 1901.	*LX, 59*
Thorp, Richard Fenwick	A. M. Oct. 5, 1904. M. Mar. 5, 1907.	July 28, 1908.	....
Thurston, Robert Henry	M. Dec. 6, 1871.	Oct. 25, 1903.	....
Tidd, Marshall Martain	M. Oct. 2, 1878.	Aug. 20, 1895.	*XXXVII, 56*
Tingley, George Curtis	M. Sept. 6, 1871.	April 30, 1904.	*LIII, 51*
Totten, Joseph Gilbert	H.M. Mar. 2, 1853.	April 22, 1864.	*XXXVI, 52*
Toucey, John Montgomery	F. May 17, 1870.	Sept. 29, 1898.	*XLV, 64*
Tower, Ashley Bemis	M. Oct. 3, 1894.	July 8, 1901.	*XLIX, 36*
Tracy, Edward Huntington	M. June 13, 1868.	Aug. 28, 1875.	I, 33
Tracy, John F.	F. Jan. 20, 1873.	Feb. 13, 1878.	IV, 7
Trafton, Gilman	M. Jan. 4, 1871.	May 25, 1887.	XV, 4
Truesdell, Charles	M. Sept. 15, 1869.	April 23, 1894.	*XXXVI, 58*
Tubbs, Joseph Nelson	M. Sept. 3, 1884.	Sept. 20, 1909.	....
Tullock, Alonzo J.	M. June 6, 1883.	July 21, 1904.	*LIV, 53*
Tutton, Charles Harold	M. Oct. 2, 1901.	June 19, 1908.	*LXII, 56*
Tyson, Henry	M. July 10, 1872.	Sept. 1, 1877.	IV, 11
Ubsdell, John Arnold	A. June 7, 1905.	April 23, 1909.	....
Van der Hoek, Jacobus	M. April 7, 1897.	Dec. 22, 1909.	....
Vanderpool, Eugene	M. Sept. 2, 1874.	July 12, 1903.	....
Van Slooten, William	M. Nov. 3, 1897.	Dec. 14, 1901.	....

---

* The italic references in this column are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

Name.	Date of Election.	Date of Death.	Memoirs.*
AUGHAN, FREDERIC WILLIS	M. Feb. 17, 1869.	Oct. 19, 1887.	XV, 44
AUGHN, CLARENCE GEORGE	M. Nov. 7, 1906.	Aug. 4, 1908.	*LXII, 562*
EAZIE, JOSEPH	M. May 3, 1876.	Mar. 2, 1897.	....
INTON, FRANCIS LAURENS	M. Aug. 5, 1868.	Oct. 6, 1879.	VIII, 91
AINWRIGHT, JONATHAN	M. Feb. 3, 1892.	Oct. 11, 1907.	....
AITE, CHRISTOPHER CHAMPLIN	M. Mar. 3, 1880.	Feb. 21, 1896.	*XLIX, 363*
ALKER, GEORGE CLARKE	F. Feb. 6, 1873.	April 12, 1905.	....
ALKER, JOSEPH MILTON	A. M. April 3, 1901.	Jan. 7, 1908.	....
ALKER, WILLIAM WILLIAMS	M. Oct. 6, 1880.	Sept. 23, 1893.	XIX, 174
ALLING, HENRY FRANCIS	M. May 6, 1868.	April 8, 1888.	XV, 140
ALTON, LOUIS ROBERTS	M. April 1, 1885.	Nov. 9, 1885.	*XXXVI, 586*
ARD, LEBBEUS BALDWIN	M. Mar. 16, 1870.	July 2, 1901.	....
ARDLAW, JAMES ROBERT	M. Mar. 3, 1886.	Dec. 27, 1891.	XVIII, 96
ARE, REUEL WILLARD	M. April 1, 1874.	Sept. 10, 1903.	....
ARMAN, FREDERICK CONOVER	A. M. Jan. 3, 1900. M. May 3, 1904.	April 27, 1908.	....
ATKINS, JOHN ELFRETH	A. Jan. 2, 1889.	Aug. 11, 1903.	....
AY, ROBERT ATTWELL	M. June 7, 1893.	April ‡ 1901.	....
EBER, CHRISTIAN PHILIPP MAX MARIA, *Baron* VON	H. M. June 2, 1880.	April 18, 1881.	VIII, 89
EIR, FREDERIC CANDEE	M. Aug. 7, 1872.	Mar. 1, 1899.	....
ELCH, ASHBEL	M. Aug. 7, 1872.	Sept. 25, 1882.	IX, 137
ELD, FREDERICK FLOYD	M. Sept. 3, 1884.	June 28, 1890.	XVII, 203
ELLINGTON, ARTHUR MELLEN	M. May 4, 1881.	May 16, 1895.	XXI, 199
ELLMAN, DAVID WILLARD	M. Oct. 5, 1870.	Aug. 18, 1898.	....
ELLS, CLINTON GLENCAIRN	J. Mar. 5, 1901. A. M. Mar. 1, 1905.	Aug. 16, 1908.	*LXIV, 590*
ELLS, DANIEL L.	F. June 13, 1883.	Nov. 24, 1884.	XI, 132
HEATON, EDWARD	A. Feb. 4, 1880.	Mar. 6, 1889.	....
HEELER, ORLANDO BELINA	M. Nov. 2, 1887.	June 3, 1896.	*XXXVI, 587*
HIPPLE, SQUIRE	H. M. May 6, 1868.	Mar. 15, 1888.	*XXXVI, 527*
HITCOMB, HENRY DONALD	M. Feb. 21, 1872.	Jan. 26, 1910.	....
HITE, WILLIAM HOWARD	M. Mar. 5, 1873.	Dec. 11, 1895.	*XLV, 635*
HITELAW, JOHN	M. Feb. 5, 1873.	June 16, 1892.	XVIII, 191
HITFORD, OSCAR F.	M. Dec. 6, 1871.	May 21, 1902.	*XLIX, 364*
HITMAN, THOMAS JEFFERSON	M. June 29, 1868.	Nov. 25, 1890.	XVIII, 103
HITNEY, NELSON OLIVER	M. Mar. 1, 1893.	Mar. 18, 1901.	....
HITTEN, NATHAN HOLLIS	M. June 7, 1876.	Aug. 23, 1905.	....
HITTON, ANDREW DEMPSTER	M. May 6, 1891.	Feb. 23, 1892.	XX, 85
IGHTMAN, HENRY MORSE	M. April 2, 1873.	April 3, 1885.	XII, 124
IGHTMAN, WILLARD HUMPHREY	M. Sept. 5, 1888.	Oct. 29, 1889.	XVI, 218

---

* The italic references in this column are to the volume and page of *Transactions*, in hich the Memoirs prepared after January 1st, 1896, were published; the other figures efer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that ate will be found.

‡ Exact date of death unknown.

DECEASED MEMBERS W-Z

Name.	Date of Election.	Date of Death.	Memoirs
Willard, James Eager	M. May 1, 1899.	Mar. 8, 1909.	......
Williams, Edward Higginson	M. Sept. 5, 1883.	Dec. 21, 1899.	......
Williams, Norman A.	M. Feb. 17, 1869.	Oct. 12, 1879.	VIII,
Williams, William	F. June 16, 1870.	Sept. 10, 1876.	......
Williamson, William Garnett	M. April 4, 1883.	Aug. 2, 1898.	*XLI, 6*
Wilson, Arthur Owen	M. Mar. 7, 1888.	Dec. 20, 1891.	XVIII, 1
Wilson, John Allston	M. June 7, 1876.	Jan. 19, 1896.	*XXXVI, 5*
Wilson, Joseph Miller	M. April 2, 1873.	Nov. 24, 1902.	*L, 5*
Wilson, William Hasell	H. M. Aug. 2, 1892.	Aug. 17, 1902.	....
Wilson, William Willard	M. Jan. 5, 1870.	Feb. 7, 1887.	XIII,
Wisner, George Y.	M. April 5, 1876.	July 3, 1906.	......
Wood, Arthur Hastings	J. Mar. 31, 1891.	April 2, 1892.	XVIII, 1
Wood, Charles	A. M. July 4, 1894.	Nov. 28, 1895.	*XXXVI, 5*
Woollard, George Clifton	J. April 3, 1900.	June 3, 1905.	*LV,*
Worthen, William Ezra	M. Dec. 4, 1867. H. M. April 4, 1893.	April 2, 1897.	*XL, 5*
Worthington, Henry R.	M. Jan. 5, 1876.	Dec. 17, 1880.	......
Wright, George Francis	M. Jan. 4, 1888.	Aug. 20, 1892.	XVIII, 2
Wright, Horatio Gouverneur	H. M. Mar. 3, 1890.	July 2, 1899.	*XLVI, 5*
Wright, Joshua Butler	F. May 24, 1870.	Oct. 31, 1877.	......
Wright, Moses Hannibal	J. Jan. 2, 1900. M. Sept. 3, 1902.	June 8, 1906.	......
Wright, William Wierman	M. Mar. 3, 1875.	Mar. 9, 1882.	VIII, 1
Würtele, Arthur Sheppard Campbell	M. Mar. 5, 1873.	Mar. 20, 1899.	......
Yeatman, Henry Clay	J. May 7, 1890.	Dec. 20, 1896.	*XL, 5*
Yorke, Edward	M. Nov. 1, 1882.	May 28, 1884.	XI, 1
Young, Eddy Elbert	A. M. Jan. 6, 1904.	June 1, 1906.	*LVIII, 5*
Young, Herbert Andrew	J. May 7, 1884.	Dec. 8, 1894.	XXI,
Young, William Clark	H. M. Mar. 1, 1892.	Dec. 22, 1893.	XIX, 1
Zeller, Albert Henry	J. May 7, 1890. A. M. April 7, 1897.	Nov. 2, 1906.	*LVIII, 5*
Zipperlein, Joseph William	A. June 4, 1901.	July 22, 1907.	*LIX, 5*

---

* The italic references in this column are to the volume and page of *Transactions*, which the Memoirs prepared after January 1st, 1896, were published; the other figur refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than th date will be found.

ALPHABETICAL LIST OF MEMBERS

NOTE—The figures after the abbreviation of the classification of membership denote the page upon which the name, official title, address and date of membership may be found.

PAGE
Abbot, F. V. M. 34
Abbot, F. W. M. 34
Abbott, E. L. M. 34
Abbott, E. T. M. 34
Abbott, F. W. M. 34
Abbott, H. Jun. 245
Abella, J. Assoc. M. 153
Abrams, D. A. Jun. 245
Ackenheil, A. C. Assoc. M. 153
Ackerman, A. S. Assoc. M. 153
Ackerman, E. R. Assoc. 237
Ackerman, J. W. M. 34
Adam, R. M. 34
Adams, A. Assoc. M. 153
Adams, A. L. M. 34
Adams, E. D. F. 274
Adams, E. E. Assoc. M. 153
Adams, E. G., Jr. M. 34
Adams, E. M. Assoc. M. 153
Adams, F. M. 34
Adams, H. S. M. 34
Adams, R. E. Assoc. M. 153
Addison, C. L. Assoc. M. 153
Adey, J. S. Jun. 245
Adey, W. H. Assoc. M. 153
Adgate, F. W. Assoc. M. 153
Aertsen, G. M. 34
Affelder, L. J. M. 34
Affleck, M. H. S. Jun. 245
Africa, J. M. M. 34
Agramonte, A. A. Assoc. M. 153
Ahern, J. M. 34
Aiken, W. A. M. 34
Aikenhead, J. R. Assoc. M. 153
Aims, W. I. M. 34
Alber, H. M. 34

PAGE
Albertson, C. M. 35
Albree, R. Assoc. M. 153
Albright, J. J. F. 274
Alden, C. A. M. 35
Alden, H. C. M. 35
Alden, J. F. M. 35
Alderman, C. A. M. 35
Alderman, C. E. M. 35
Alderson, A. B. Assoc. M. 153
Alderson, W. H. Jun. 245
Aldrich, T. H. M. 35
Alexander, H. J. Assoc. M. 153
Alexander, J. H. Assoc. M. 153
Alexander, K. Assoc. M. 153
Alexander, R. L. Assoc. M. 153
Alfred, F. H. M. 35
Alison, T. H. M. 35
Allan, A. G. Assoc. M. 153
Allan, P. M. 35
Allard, T. T. M. 35
Allardice, E. R. B. Assoc. M. 154
Allen, A. M. 35
Allen, C. A. M. 35
Allen, C. F. M. 35
Allen, C. H. M. 35
Allen, C. L. M. 35
Allen, C. M. Assoc. M. 154
Allen C. S. Jun. 245
Allen, E. Y. Assoc. M. 154
Allen, F. W. Assoc. M. 154
Allen, H. C. M. 35
Allen, H. D. Jun. 245
Allen, J. L. Assoc. M. 154
Allen, J. P. M. 35
Allen, K. M. 35
Allen, R. L. Assoc. M. 154

Name		Page
Allen, W. A.	M.	36
Allen, W. B.	M.	36
Allen, W. F.	Assoc. M.	154
Allen, W. H.	M.	35
Allin, T. D.	M.	36
Allison, C. T.	Assoc. M.	154
Almirall, R. F.	M.	36
Alsberg, J.	Assoc. M.	154
Altstaetter, F. W.	Assoc. M.	154
Alvord, J. W.	M.	36
Ambler, D. G.	Assoc.	237
Ambler, J. N.	M.	36
Amburn, W. W.	Assoc. M.	154
Ambursen, N. F.	M.	36
Ames, G. M.	Assoc. M.	154
Ammann, O. H.	Assoc. M.	154
Amweg, F. J.	M.	36
Anderberg, E.	Jun.	245
Andersen, C.	M.	36
Anderson, C. L. B.	Assoc. M.	154
Anderson, D. G.	Assoc. M.	154
Anderson, G. G.	M.	36
Anderson, J. T. N.	M.	36
Anderson, L. W.	Jun.	245
Anderson, R.	Assoc.	237
Anderson, R. H.	Assoc. M.	154
Anderson, W. P.	M.	36
Anderson, W. T.	Assoc. M.	154
Andrews, D. H.	M.	36
Andrews, D. M.	M.	36
Andrews, G. C.	Jun.	245
Andrews, H.	M.	36
Andrews, H. B.	M.	36
Andros, F. W.	Assoc. M.	154
Andrus, L. A.	Jun.	245
Angier, W. E.	M.	36
Annan, C. Le R.	M.	36
Anthony, C., Jr.	M.	36
Anthony, C. C.	M.	36
Anthony, W. L.	Assoc. M.	154
Appel, H. A.	Jun.	245
Apple, C. E.	Jun.	245
Appleton, T.	M.	36
Arango, R. M.	M.	36
Arce, J. A.	Assoc. M.	154
Archbald, J.	M.	37
Archer, A. R.	Assoc. M.	154
Archer, W.	M.	37
Archibald, P. S.	M.	37
Archibald, W. M.	Assoc. M.	154
Arend, A. C.	Assoc. M.	154
Arentz, F. C. H.	M.	37
Argollo, M. de T. e	M.	37
Armitage, G. W.	Assoc. M.	155
Armour, C. W. L.	Assoc. M.	155
Armstrong, A. F.	Assoc. M.	155
Armstrong, C. J.	Assoc. M.	155
Armstrong, G. S., Jr.	Jun.	245
Armstrong, R. S.	Assoc. M.	155
Armstrong, R. W.	Assoc. M.	155
Armstrong, W. C.	M.	37
Armstrong, W. R.	M.	37
Arn, W. G.	Assoc. M.	155
Arnold, B. J.	M.	37
Arnold, W. H.	M.	37
Arnott, R. F.	Assoc. M.	155
Arthur, H. E.	M.	37
Artingstall, S. G.	M.	37
Ash, D.	Assoc. M.	155
Ash, H. C.	M.	37
Ash, L. R.	Assoc. M.	155
Ashbaugh, L. E.	M.	37
Ashbridge, R. I. D.	M.	37
Ashbrook, C. D.	Jun.	245
Ashmead, F. M.	M.	37
Ashmead, P. H.	M.	37
Ashton, W.	M.	37
Aspinwall, T.	M.	37
Asserson, H. R.	M.	37
Atkins, H. B.	Assoc. M.	155
Atkinson, A.	Assoc. M.	155
Atkinson, J. B.	M.	37
Atterbury, C. De La P.,	Assoc. M.	155
Atterbury, W. W.	M.	37
Atwater, A. B.	M.	37
Atwell, H. H.	Assoc.	237
Atwood, E. F.	Assoc. M.	155
Atwood, J. A.	M.	37
Atwood, T. C.	Assoc. M.	155
Atwood, W. B.	Jun.	245
Atwood, W. G.	Assoc. M.	155
Auchincloss, J. W.	Assoc.	237
Auchincloss, W. S.	M.	37
Auryansen, F.	M.	38
Aus, G.	M.	38

		Page
Austin, W. E	M.	38
Auten, C. I	Jun.	245
Avakian, J. C	Assoc. M.	155
Averill, F. L	M.	38
Axtell, D	M.	38
Aycrigg, W. A	M.	38
Aylett, P	Assoc. M.	155
Ayres, C. M	M.	38
Ayres, L. E	Jun.	245
Babb, C. C	M.	38
Babcock, F	Jun.	245
Babcock, H. N	M.	38
Babcock, W. S	Assoc. M.	155
Babé, J. M	Assoc. M.	155
Bachert, A. E	M.	38
Backes, W. J	Assoc. M.	156
Bacon, A. W	Jun.	245
Bacon, G. M	M.	38
Bacon, J. H	M.	38
Bacot, W. S	M.	38
Badenhausen, J. P	M.	38
Baeta-Neves, L	Assoc. M.	156
Bailey, W. M	M.	38
Baily, T. C. J., Jr	M.	38
Baird, H. C	M.	38
Baird, S. P	M.	38
Bake, W. S	Assoc. M.	156
Bakenhus, R. E	M.	38
Baker, C. H	M.	39
Baker, E. B	Assoc. M.	156
Baker, H. C., Jr	Assoc. M.	156
Baker, H. E	Assoc. M.	156
Baker, H. J. M	Assoc. M.	156
Baker, H. W	M.	39
Baker, I. O	M.	39
Baker, P. S	Assoc. M.	156
Baker, S	M.	39
Baker, S. K	Assoc. M.	156
Baker, W. E	M.	39
Balch, L. R	Assoc. M.	156
Balch, W. H	M.	39
Baldridge, J. R	Jun.	246
Baldwin, A. S	M.	39
Baldwin, E. H	M.	39
Baldwin, F. H	M.	39
Baldwin, G. H	Assoc. M.	156
Baldwin, G. P	M.	39
Baldwin, H. E	Assoc. M.	156
Baldwin, T. W	M	39
Baldwin, W	M.	39
Baldwin, W. H	M.	39
Baldwin, W. J	M.	39
Ball, C. B	M.	39
Ball, L. A	Assoc. M.	156
Ballard, R	M.	39
Ballinger, W. F	M.	39
Ballou, H. W	Assoc. M.	156
Balz, L. C. F	Assoc. M.	156
Bamford, W. B	Assoc. M.	156
Bance, C. W	Assoc. M.	156
Bandy, J. M	Assoc. M.	156
Banker, E. W	Jun.	246
Banks, C. W	Jun.	246
Banks, G. H	Assoc. M.	156
Banks, J. E	Assoc. M.	156
Bannister, C. L	Assoc. M.	156
Bantel, E. C. H	Assoc. M.	156
Barber, W. D	M.	39
Barbour, F. A	M.	39
Barcroft, F. T	M.	39
Bard, G. P	M.	39
Bardol, F. V. E	M.	39
Barker, C. W. T	Assoc. M.	157
Barker, J. M	Jun.	246
Barker, L. O., Jr	Jun.	246
Barkmann, E. H	Assoc. M.	157
Barlow, A. E., Jr	Jun.	246
Barlow, De W. D	Assoc. M.	157
Barlow, J. E	Jun.	246
Barlow, J. Q	M.	39
Barlow, J. S	Assoc. M.	157
Barnard, E. C	M.	40
Barnard, E. E	Jun.	246
Barnard, J. F	M.	40
Barnard, W. K	Assoc. M.	157
Barnes, E. H	M.	40
Barnes, F. A	Assoc. M.	157
Barnes, H. E	Jun.	246
Barnes, M. G	M.	40
Barnes, T. H	M.	40
Barnes, W. E	Assoc. M.	157
Barnes, W. T	Assoc. M.	157
Barnett, J. W	M.	40
Barnett, R. C	Assoc. M.	157
Barney, P. C	Assoc. M.	157

Page
Barr, J. C ... Assoc. M. 157
Barragan, M. M ... M. 40
Barrally, T. W ... M. 40
Barratt, S. A ... Assoc. M. 157
Barrett, R. E ... Jun. 246
Barrows, H. K ... M. 40
Barshell, F. B ... Jun. 246
Bartell, M. J ... Assoc. M. 157
Bartoccini, A ... Assoc. M. 157
Barton, C. L ... Assoc. M. 157
Barton, W. C ... Assoc. M. 157
Bascom, H. F ... M. 40
Bascome, W. R ... Assoc. M. 157
Basinger, J. G ... M. 40
Bass, F. H ... Assoc. M. 157
Bassel, R ... M. 40
Bassell, G. M ... Assoc. M. 157
Bassett, C. P ... M. 40
Bassett, G. B ... M. 40
Bassett, J. B ... M. 40
Bassett, R. J ... Assoc. M. 157
Batchelder, B. F ... Assoc. M. 157
Bates, L., Jr ... Jun. 246
Bates, O ... M. 40
Bates, W. B ... Assoc. M. 158
Battie, H. S ... Jun. 246
Baucus, W. I ... M. 40
Bauer, J. L ... M. 40
Baum, F. G ... Assoc. M. 158
Baum, G ... M. 40
Bausher, C. I ... Assoc. M. 158
Baxter, D. E ... Assoc. M. 158
Baxter, F. E ... M. 40
Baxter, G. S ... M. 41
Bayley, C. A. D ... Assoc. M. 158
Baylis, A. R ... Assoc. M. 158
Bayliss, J. Y ... M. 41
Bayliss, R. T ... M. 41
Beach, J. G ... Assoc. M. 158
Beach, L. H ... M. 41
Beach, R. J ... M. 41
Beach, W. N ... Assoc. M. 158
Beahan, W ... M. 41
Beal, G. S ... Assoc. M. 158
Beale, C ... Assoc. M. 158
Beale, H. O ... Assoc. M. 158
Beard, E. J ... M. 41
Beardsley, A ... M. 41

Page
Beardsley, J. W ... M. 41
Beattie, R. H ... M. 41
Beatty, P. A ... M. 41
Bebb, E. C ... Assoc. M. 158
Becker, E. J ... Jun. 246
Becker, R. C ... Jun. 246
Becker, S. A ... Assoc. M. 158
Beckwith, F ... M. 41
Beebee, R. A ... Jun. 246
Beekman, J. V., Jr ... Assoc. M. 158
Beeler, J. A ... M. 41
Beer, P ... Assoc. M. 158
Beeson, A. C ... Assoc. M. 158
Begien, R. N ... Assoc. M. 158
Behrend, B. A ... M. 41
Belcher, W. E ... Assoc. M. 158
Belden, E. T ... Assoc. 237
Belden, H. A ... M. 41
Belknap, F. W ... Assoc. M. 158
Belknap, J. M ... M. 41
Belknap, W. E ... M. 41
Belknap, W. R ... F. 274
Bell, A ... M. 41
Bell, Alfred C ... Assoc. M. 158
Bell, Alonzo C ... M. 41
Bell, George J ... M. 41
Bell, Gilbert J ... M. 41
Bell, H. P ... M. 41
Bell, J. R ... M. 42
Bellinger, L. F ... M. 42
Bellows, D. E ... Assoc. M. 158
Bellows, O. F ... M. 42
Bellows, S. R ... Jun. 246
Belzner, T ... Jun. 246
Bement, R. B. C ... M. 42
Benedict, F. N ... Jun. 246
Benedict, H. A ... M. 42
Benedict, N ... Jun. 246
Bennet, O. G., Jr ... Jun. 246
Bennett, C. N ... Assoc. M. 158
Bennett, F. W ... M. 42
Bennett, L. J ... Assoc. 237
Bennett, S. G ... M. 42
Bensel, J. A ... M. 42
Benson, N. D ... Assoc. M. 159
Benson, O ... M. 42
Bent, C. C. F ... M. 42
Bent, S ... Assoc. 237

PAGE
Benton, L. S. ... Jun. 246
Bentzon, A. B. ... M. 42
Benzenberg, G. H. ... M. 42
Bernegau, R. C. C. M. ... Assoc. 237
Bergen, V. B. ... M. 42
Bergendahl, G. S. ... Assoc. M. 159
Berger, B. ... Assoc. M. 159
Berger, J ... Assoc. M. 159
Bergman, H. M. ... Jun. 246
Berle, K ... M. 42
Bernstein, L. ... Jun. 247
Berquist, A. S. F. ... M. 42
Berry, C. ... Assoc. M. 159
Berry, F. R. ... Assoc. M. 159
Berry, G. ... M. 42
Berry, J. B. ... M. 42
Berry, L. G. ... Assoc. M. 159
Berry, T. ... M. 42
Best, J. H. ... Assoc. M. 159
Beswick, J. E. ... Jun. 247
Bettes, C. R. ... M. 42
Betts, E. E. ... Assoc. M. 159
Betts, F. K. ... M. 42
Betts, R. T. ... M. 42
Beugler, C. E. ... Assoc. M. 159
Beugler, E. J. ... M. 42
Biddle, J. ... M. 42
Biddle, W. F. ... M. 42
Bieler, A. H. ... Assoc. M. 159
Bienenfeld, A. M. ... M. 43
Bienenfeld, B. ... M. 43
Bigelow, E. M. ... M. 43
Biggs, C. A. ... Jun. 247
Bilger, H. E. ... Assoc. M. 159
Billin, C. E. ... M. 43
Billings, A. W. K ... M. 43
Billingsley, J. W. ... Assoc. M. 159
Billwiller, E. O. ... Jun. 247
Bilyeu, C. S. ... Jun. 247
Bingham, C. A. ... Jun. 247
Binkley, G. H. ... M. 43
Bisbee, F. M. ... M. 43
Bischoff, J. M. ... Assoc. M. 159
Bishop, H. K. ... M. 43
Bishop, H. N. ... Jun. 247
Bishop, L. E. ... Jun. 247
Bishop, W. I. ... M. 43
Bissell, C. S. ... M. 43

PAGE
Bissell, C. T. ... Assoc. M. 159
Bissell, F. E. ... M. 43
Bissell, H ... M. 43
Bixby, W. F. ... Jun. 247
Bixby, W. H. ... M. 43
Blaauw, G ... Assoc. M. 159
Black, A. L. ... M. 43
Black, E. F. ... Assoc. M. 159
Black, G. G. ... Assoc. M. 159
Black, R. D. ... Jun. 247
Black, R. P. ... Assoc. M. 159
Black, W. M. ... M. 43
Blackburn, N. T. ... Jun. 247
Blackford, F. W. ... M. 43
Blackmore, G. G. ... Assoc. M. 159
Blackwell, F. O. ... M. 43
Blackwell, P. A. ... Assoc. M. 159
Blair, McC. P. ... Assoc. M. 159
Blake, C. ... M. 43
Blakeley, G. H. ... M. 43
Blakeslee, C. ... M. 43
Blamphin, A. M. N. ... Assoc. M. 160
Blanchard, A. H. ... M. 43
Blanchard, M. ... Assoc. M. 160
Bland, G. P. ... M. 44
Bland, J. C. ... M. 44
Bland, M. C. ... Assoc. M. 160
Blatchford, E. W. ... F. 274
Blatt, M. ... Assoc. M. 160
Blauvelt, L. D. ... M. 44
Blaylock, J. C. ... Assoc. M. 160
Bliem, D. W. ... Assoc. M. 160
Bliss, E. P. ... Assoc. M. 160
Bliss, G. H. ... Assoc. M. 160
Blodgett, A. M. ... M. 44
Blodgett, J. ... Assoc. M. 160
Blood, C. F. ... Assoc. M. 160
Bloom. J G. ... M. 44
Bloss, R. P. ... M. 44
Blossom, F. ... M. 44
Bluhm, H. W. ... Jun. 247
Blunt, W. T. ... M. 44
Blythe, L. H ... Assoc. M. 160
Boardman, C. S. ... M. 44
Boardman, H. E. ... Assoc. M. 160
Boardman, H. S. ... Assoc. M. 160
Boatrite, J. E. ... Assoc. M. 160
Bock, C. A. ... Jun. 247

ALPHABETICAL LIST B

		Page
Body, J. B	M.	44
Boecklin, W.	M.	44
Bogart, J.	M.	44
Bogart, S. S.	Assoc.	237
Bogen, L. E.	Assoc. M.	160
Bogert, C. L.	Jun.	247
Boggs, E. M.	M.	44
Boggs, F. C.	M.	44
Bogue, V. G.	M.	44
Boller, A. P.	M.	44
Boller, A. P., Jr	Assoc. M.	160
Bolton, C. M	M.	44
Bolton, R. P.	M.	44
Boltz, T. F	Assoc. M.	160
Bond, E. A	M.	44
Bond, G. M.	M.	44
Bond, G. W., Jr	Assoc. M.	160
Bond, J. B.	Assoc. M.	160
Boniface, A.	Jun.	247
Bonnett, C. P	Assoc. M.	160
Bonnyman, A.	M.	44
Bontecou, D.	M.	44
Bonzano, A	M.	44
Bonzano, M. F	M.	45
Booth, G. W	M.	45
Booth, W. H	M.	45
Booz, H. C.	Assoc. M.	160
Boright, W. P.	M.	45
Borland, B.	Jun.	247
Bos, G. A.	Assoc. M.	161
Bosler, H. S.	M.	45
Bott, J. B.	M.	45
Boucher, W. J	Assoc. M.	161
Boughton, W. H	Assoc. M.	161
Bourne, T. J.	Assoc. M.	161
Bouton, H.	Assoc.	237
Bowditch, E. W.	Jun.	247
Bowditch, J. H.	Assoc. M.	161
Bowen, E. I.	Assoc. M.	161
Bowen, O. S.	M.	45
Bowen, S. W.	Assoc. M.	161
Bower, C. P.	M.	45
Bowers, G.	M.	45
Bowie, A. J	M.	45
Bowie, C. P	Assoc. M.	161
Bowker, W. L.	M.	45
Bowler, F. C.	Assoc. M.	161
Bowman, A. L.	M.	45
Bowman, C. A.	M.	45
Bowne, W. H.	Assoc. M.	161
Bowser, E. H.	M.	45
Boyd, B. B.	Assoc. M.	161
Boyd, J. C.	M.	45
Boyd, R. W	Assoc. M.	161
Boyd, W. C	M.	45
Boyden, H. C	M.	45
Boyer, C. C.	Assoc. M.	161
Boynton, G. H.	M.	45
Brace, J. H.	M.	45
Brackenridge, J. C.	M.	45
Brackenridge, W. A.	M.	45
Brackett, D.	M.	45
Bradbury, E. G.	M.	45
Bradford, W.	M.	46
Bradley, C. W.	Assoc.	237
Bradley, D. E.	M.	46
Bradley, E. E.	M.	46
Bradshaw, C.	Assoc. M.	161
Bradshaw, S. W.	Assoc. M.	161
Brady, J.	Assoc. M.	161
Brady, S. D.	M.	46
Brainard, A. S	Jun.	247
Brainard, O.	M.	46
Braine, L. F.	Assoc.	237
Brainerd, H. A	Jun.	247
Bramwell, G. W.	M.	46
Branch, E. W	M.	46
Branch, L. V. N.	Assoc. M.	161
Branch, T. P.	Assoc. M.	161
Branne, J. S	Assoc. M.	161
Bratton, E. E.	Assoc. M.	161
Braune, G. M.	Assoc. M.	161
Braxton, J. M.	M.	46
Brazer, G. H.	M.	46
Breckinridge, W. L.	M.	46
Breed, C. B.	Assoc. M.	161
Breed, H. E	Assoc. M.	161
Breen, J. E.	M.	46
Breithaupt, W. H.	M.	46
Breitzke, C. F.	Jun.	247
Bremer, L. P.	Jun.	247
Bremner, G. H.	M.	46
Brendlinger, P. F.	M.	46
Breneman, P. B.	Assoc. M.	162
Brenn, C. F.	Assoc. M.	162
Brennan, J. L.	Jun.	247

		Page
Brenneke, W. G	M.	46
Brereton, T. J	Assoc. M.	162
Breuchaud, J	M.	46
Breuchaud, J. R	Jun.	247
Brewer, B	M.	46
Brewer, J. I	Assoc. M.	162
Brewer, W. S	Jun.	247
Brewster, H. B	M.	46
Briggs, B. E	M.	46
Briggs, H. A	Assoc. M.	162
Briggs, J. A	M.	46
Briggs, R. E	M.	46
Briggs, W. C	M.	46
Bright, C. E	Assoc. M.	162
Brillhart, J. H	Assoc. M.	162
Brinckerhoff, A. G	M.	46
Brink, L. C	Assoc. M.	162
Brinkley, M. H	Assoc. M.	162
Brinsmade, D. E	Assoc. M.	162
Brinsmade, D. S	M.	47
Britt, D. D	M.	47
Broadhurst, W. G	Jun.	247
Brodie, O. L	Assoc. M.	162
Brogan, T. B	Assoc. M.	162
Brohm, W. C	M.	47
Bromley, A. H., Jr.	Assoc.	237
Brook-Fox, E	Assoc. M.	162
Brooke G. D	Assoc. M.	162
Brooks, D. W	Assoc.	237
Brooks, F	M.	47
Brooks, J. N	Jun.	248
Brooks, J. P	Assoc. M.	162
Brooks, J. R	Jun.	248
Brooks, M. E	Assoc. M.	162
Brower, E. S	Assoc. M.	162
Brower, I. C	Assoc. M.	162
Brown, A. R	Jun.	248
Brown, A. T	Assoc. M.	162
Brown, B. L	M.	47
Brown, B. S	Assoc. M.	162
Brown, C.	Assoc. M.	163
Brown, C. B., Jr	Assoc. M.	163
Brown, C. C	M.	47
Brown, C. E	Assoc. M.	162
Brown, C. F	Assoc. M.	163
Brown, C. O	M.	47
Brown, D. H	Jun.	248
Brown, E. I	M.	47
Brown, G. C	Jun.	248
Brown, J. G	Assoc.	237
Brown, Le G	M.	47
Brown, L. L	M.	47
Brown, L. W	M.	47
Brown, M. F	M.	47
Brown, M. W	Assoc. M.	163
Brown, N. F	M.	47
Brown, P. F	M.	47
Brown, P. G	M.	47
Brown, R. C	M.	47
Brown, Ralph H	M.	47
Brown, Robert H	Jun.	248
Brown, R. K	Assoc. M.	163
Brown, R. M	Assoc. M.	163
Brown, S. C	Assoc. M.	163
Brown, S. P	Assoc. M.	163
Brown, T. E	M.	47
Brown, T. R	Assoc.	237
Brown, W. C	Jun.	248
Brown, W. G	M.	47
Brown, W. L	M.	47
Brown, W. M	M.	47
Brown, W. P	M.	47
Browne, G. H	M.	47
Browne, J. S	M.	48
Browne, W. R	M.	48
Brownell, E. H	M.	48
Brownell, L. D	Assoc. M.	163
Browning, G. E	M.	48
Brownlee, J. L	M.	48
Brua, E. G	Jun.	248
Bruce, F. W	M.	48
Bruce, J. M	Assoc.	237
Brumley, D. J	M.	48
Bruning, H. D	Assoc. M.	163
Brunner, J	M.	48
Bruntlett, E. H	Jun.	248
Brush, C. F	Assoc. M.	163
Brush, W. W	Assoc. M.	163
Bryan, C. W	M.	48
Bryan, F. A	M.	48
Brydone-Jack, E. E	M.	48
Bryson, A	M.	48
Bryson, T. B	Assoc. M.	163
Buchanan, E. E	M.	48
Buchholz, C. W	M.	48
Buck, C. M	Assoc. M.	163

Page
Buck, H. R ... M. 48
Buck, R. S. ... M. 48
Buck, W. E ... M. 48
Budell, A. E ... Jun. 248
Budge, E ... M. 48
Budge, E. B. ... M. 48
Buehler, W. ... M. 48
Buffinton, B. T. ... M. 48
Bugbee, N. A. K ... Assoc. M. 163
Bull, G. M ... M. 48
Bullock, W. D ... M. 49
Bumsted, E. B ... Assoc. M. 163
Bunnel, W. C. ... Assoc. M. 163
Burbank, G. B ... M. 49
Burchard, A. W ... Assoc. M. 163
Burden, J. ... M. 49
Burden, M ... Assoc. M. 163
Burdett, F. A ... M. 49
Burdick, C. B ... Assoc. M. 163
Burgess, A. S ... M. 49
Burgess, G. H ... M. 49
Burgess, H ... M. 49
Burgess, P ... Assoc. M. 163
Burgoyne, J. H., Jr. ... Assoc. M. 163
Burke, J. T. ... M. 49
Burke, M. D ... M. 49
Burke, R. H ... Jun. 248
Burley, H. B ... M. 49
Burnham, G., Jr ... Assoc. 237
Burnham, G. E. ... Jun. 248
Burns, C. S ... M. 49
Burns, E. C. ... M. 49
Burns, J. P. ... Assoc. M. 163
Burns, L. A. ... Assoc. M. 163
Burns, W. E. ... Jun. 248
Burpee, G. W ... Jun. 248
Burpee, M ... M. 49
Burr, E. ... M. 49
Burr, M. C. ... Jun. 248
Burr, W. H ... M. 49
Burrage, J. O ... Assoc. M. 164
Burrell, G. S. ... Assoc. M. 164
Burroughs, F. ... Jun. 248
Burroughs, H. R. ... Jun. 248
Burrowes, H. G ... M. 49
Burrows, G. L ... Assoc. 237
Burt, H J ... M. 49
Burton, A. E. ... M. 49

Page
Burton, W ... Assoc. M. 164
Burton, W. J ... Jun. 248
Burwell, R. L. ... Assoc. M. 164
Bush, E. W ... M. 49
Bush, H. D. ... M. 49
Bush, L. ... M. 49
Bush, P. L ... Assoc. M. 164
Bushell, A. W ... Jun. 248
Bushnell, H. E ... Jun. 248
Butcher, W. L ... Assoc. M. 164
Butchers, E. B. ... Assoc. M. 164
Butler, A. D. ... Assoc. M. 164
Butler, J. S ... Assoc. M. 164
Butler, M. J. ... M. 50
Butterfield, F. E ... M. 50
Butterfield, H. M ... Assoc. M. 164
Butts, E. P. ... M. 50
Butz, G. W ... Assoc. M. 164
Buzzell, J. W ... Assoc. M. 164
Byam, Le R. H. ... M. 50
Byers, A. M. C ... M. 50
Byers, M. L. ... M. 50
Byllesby, H. M. ... M. 50

Cahill, J. E ... Jun. 248
Cahill, J. R. ... Jun. 248
Cahill, W. J ... M. 50
Cain, W ... M. 50
Caird, J. M ... Assoc. 237
Cairns, R. A. ... M. 50
Calder, J. W ... Jun. 248
Calderwood, I. G ... M. 50
Caldwell, F. E ... Jun. 249
Caldwell, G. B ... M. 50
Caldwell, J. W. ... Jun. 249
Caldwell, W. H. ... M. 50
Calhoun, D. A ... Jun. 249
Callaghan, J ... M. 50
Cameron, H. F ... Assoc. M. 164
Cameron J. B ... Assoc. M. 164
Cameron, K. M. ... Jun. 249
Camp, W. M. ... M. 50
Campbell, D. H ... Assoc. M. 164
Campbell, H. A ... Assoc. M. 164
Campbell, J. L. ... M. 50
Campen, G. L ... M. 50
Campion, H. T. ... M. 50
Canals, J. A. ... M. 50

Page
Canfield, E. ... M. 50
Cannon, M. M ... M. 50
Cantine, E. I ... M. 50
Cantwell, H. H ... Jun. 249
Caples, M. J ... M. 51
Cappelen, F. W ... M. 51
Carbajal, F ... Jun. 249
Carberry, R. S ... Assoc. M. 164
Carey, E. G ... Assoc. M. 164
Carlile, T. J ... M. 51
Carlin, J. P ... Assoc. M. 164
Carlisle, O. B ... Jun. 249
Carll, D. S ... M. 51
Carmalt, L. J ... M. 51
Carpenter, A. W ... M. 51
Carpenter, C. E ... Assoc. M. 164
Carpenter, C. L ... M. 51
Carpenter, G. A ... M. 51
Carpenter, J. C ... Jun. 249
Carr, A ... M. 51
Carr, W. F ... M. 51
Carrick, R. E ... Assoc. M. 164
Carroll, C. J ... Assoc. M. 165
Carroll, E ... M. 51
Carson, H. A ... M. 51
Carson, W. W ... M. 51
Carstarphen, F. C ... Assoc. M. 165
Carter, A. E ... Assoc. M. 165
Carter, E. C ... M. 51
Carter, F. H ... Assoc. M. 165
Carter, H. H ... M. 51
Carter, J. R ... M. 51
Carter, L. L ... Jun. 249
Carter, R. W ... Assoc. M. 165
Carter, S ... M. 51
Carter, W. J ... M. 51
Cartlidge, C. H ... M. 51
Carver, G. P ... Assoc. M. 165
Cary, E. R ... M. 52
Case, J. F ... M. 52
Cater, W. D ... Jun. 249
Cattell, W. A ... M. 52
Cauthorn, E. B ... Assoc. M. 165
Chace, A. M ... Jun. 249
Chace, I. M., Jr ... Assoc M. 165
Chadbourn, W. H., Jr ... M. 52
Chadbourne, E. M ... Assoc. M. 165
Chadwick, C. R ... Jun. 249

Page
Chafetz, H ... Jun. 249
Chamberlain, P. W ... M. 52
Chamberlaine, R. L ... Assoc. M. 165
Chamberlin, C. H ... M. 52
Chambers, F. T ... M. 52
Chambers, H. J ... Assoc. M. 165
Chambers, H. W ... Assoc. M. 165
Chambers, R. H ... M. 52
Chandler, E. F ... Assoc. M. 165
Chandler, E. L ... Jun. 249
Chandler, H. E ... Jun. 249
Chanute, O ... M. 52
Chapin, L. E ... M. 52
Chapleau, S. J ... M. 52
Chapman, A. G ... Jun. 249
Chapman, H. D ... Assoc. M. 165
Chapman, J. R ... M. 52
Chapman, M. D ... Assoc. 238
Chapman, P ... Assoc. M. 165
Chappell, C. E ... Jun. 249
Chappell, T. F ... M. 52
Charles, L. J ... Assoc. M. 165
Charlsworth, W. S ... Assoc. M. 165
Charnley, W ... Assoc. M. 165
Chase, C. F ... M. 52
Chase, C. F ... M. 52
Chase, F. L ... M. 52
Chase, J. C ... M. 52
Chase, M ... M. 52
Chase, R ... Assoc. M. 165
Chase, R. D ... Assoc. M. 165
Chase, W. H ... Assoc. M. 165
Chaussé, A ... Assoc. 238
Cheever, A. S ... M. 52
Cheney, H. N ... M. 52
Chester, C. E ... Assoc. M. 165
Chester, C. P ... Jun. 249
Chester, J. N ... M. 53
Chevalier, L ... Jun. 249
Chevalier, W. T ... Jun. 249
Chew, R. S ... Assoc. M. 166
Chiba, T ... Jun. 249
Chibas, E. J ... M. 53
Child, S ... M. 53
Childs, J. E ... M. 53
Childs, O. W ... M. 53
Chipman, P ... Assoc. M. 166
Chipman, W ... M. 53

		Page
Chittenden, H. M	M.	53
Choate, J. K	M.	53
Christian, G. L	M.	53
Christie, G. B	M.	53
Christie, J	M.	53
Christie, W. W	M.	53
Christy, G. L	M.	53
Church, C. T	M.	53
Church, E. C	Jun.	249
Church, F. B	M.	53
Church, I. P	Assoc.	238
Church, W. L	M.	53
Churchill, C. S	M.	53
Churchill, J. C	M.	53
Churchill, P. M	Assoc. M.	166
Cilley, M	Assoc. M.	166
Clapp, F. L	Assoc. M.	166
Clapp, G. H	Assoc. M.	166
Clapp, J. M	M.	53
Clapp, O. F	M.	53
Clapp, S. K	Assoc. M.	166
Clapp, W. A	Assoc. M.	166
Clapp, W. B	M.	53
Clark, C. H	M.	53
Clark, E	Assoc. M.	166
Clark, E. W	F.	274
Clark, G. H	M.	54
Clark, Le R. W	Jun.	249
Clark, L. V	Assoc.	238
Clark, R. N	M.	54
Clark, T. S	M.	54
Clark, Watson G	M.	54
Clark, William G	Jun.	249
Clark, W. V	Assoc. M.	166
Clarke, D. D	M.	54
Clarke, E. C	M.	54
Clarke, E. L	Assoc. M.	166
Clarke, E. W	M.	54
Clarke, G. C	M.	54
Clarke, St. J	M.	54
Clarke, T. C	M.	54
Clarke, W. D	Assoc. M.	166
Clarkson, R. C	M.	54
Class, C. F	Assoc. M.	166
Clausen, J. C	Assoc. M.	166
Clausnitzer, J	Jun.	249
Claussen, O	M.	54
Claybaugh, H. W	Assoc. M.	166
Clayton, H. H	Jun.	250
Clayton, R. M	M.	54
Clayton, T. W	M.	54
Cleaver, P. J.	Assoc. M.	166
Clement, F. H	M.	54
Clermont, J. B	M.	54
Cleveland, L. B	Jun.	250
Clifford, W. W	Jun.	250
Clinton, S. D	Assoc. M.	166
Closson, E. S	Jun.	250
Coane, J. M	M.	54
Coates, F. R	Assoc. M.	166
Cobb, S. A	Jun.	250
Cobb, S. P	Assoc. M.	166
Coburn, H. B., Jr	Jun.	250
Cochran, J	Jun.	250
Cochrane, V. H	Assoc. M.	166
Code, W. H	M.	54
Codwise, E. B	M.	54
Codwise, H. R	Assoc.	238
Coe, D	M.	54
Coe, W. W	M.	54
Coffin, A	M.	54
Coffin, T. A	M.	54
Coffin, T. DeL	Jun.	250
Cogswell, W. B	M.	55
Cohen, C	Assoc. M.	166
Cohen, F. W	M.	55
Cohen, M	M.	55
Coit, E. W	F.	274
Cokefair, F. A	Assoc. M.	166
Colby, A. L	M.	55
Colby, B. H	M.	55
Colby, S. K	Assoc.	238
Cole, A. B	Jun.	250
Cole, B	Assoc. M.	167
Cole, C. L	Assoc. M.	167
Cole, D. W	M.	55
Cole, E. S	Assoc. M.	167
Cole, G. N	Assoc.	238
Cole, H. J	M.	55
Cole, H. N	Assoc. M.	167
Cole, H. O	Assoc. M.	167
Cole, J. A	M.	55
Cole, O. F	Assoc. M.	167
Cole, W. W	M.	55
Coleman, C	M.	55
Coleman, F. A	M.	55

		Page
Coleman, H. F	Assoc. M.	167
Coleman, J. F.	M.	55
Colgan, R. J.	Jun.	250
Collar, W. F	Jun.	250
Collier, B. C	M.	55
Collingwood, F.	M.	55
Collins, C. E	Assoc. M.	167
Collins, C. P	Assoc. M.	167
Collins, D. C. N	M.	55
Collins, F. D	Assoc. M.	167
Collins, F. J	Assoc. M.	167
Collins, F. W.	Jun.	250
Collins, G. J. S	Assoc. M.	167
Collins, J. T	Assoc. M.	167
Collins, R. G., Jr	M.	55
Colnon, R. S	Assoc. M.	167
Colpitts, W. W	M.	55
Colsten, A. L	Assoc.	238
Colvin, D. D	Assoc. M.	167
Comfort, S. G	Assoc.	238
Compton, A. G	Assoc.	238
Compton, C. S	M.	55
Comstock, C. W	M.	55
Conard, C. K	M.	55
Conard, W. R	Assoc.	238
Condron, T. L	M.	55
Congdon, J. P	Assoc. M.	167
Conger, A. A	Assoc. M.	167
Conkling, C. C	M.	56
Conkling, L. De V	Assoc. M.	167
Conley, C. G	Assoc. M.	167
Conn, F. W	M.	56
Connell, H. L	Assoc. M.	167
Conner, R. M	Assoc. M.	167
Connett, A. N	M.	56
Connick, H. De H	Assoc. M.	167
Connor, E. H	M.	56
Connor, S. P	M.	56
Connor, W. D	Assoc. M.	167
Conrad, L. E	Assoc. M.	168
Constable, H	M.	56
Constance, E. C	Assoc.	238
Constant, F. H	M.	56
Contri, S	M.	56
Converse, W. H	Assoc. M.	168
Conway, G. R. G	M.	56
Conway, J. S	Assoc. M.	168
Conzelman, J. E	Assoc. M.	168
Cook, F. S	M.	56
Cook, H. A	Jun.	250
Cook, J. H	M.	56
Cook, J. W.	Jun.	250
Cooke, F. H	Assoc. M.	168
Cooke, G. R	Assoc. M.	168
Cooke, St. G. H.	Assoc. M.	168
Cooley, L. E	M.	56
Cooley, M. W	M.	56
Coombs, A. W	Jun.	250
Coombs, P. H	M.	56
Coombs, R. D	M.	56
Coombs, S. E	M.	56
Coomer, R. M	Assoc. M.	168
Cooper, D. R	Assoc. M.	168
Cooper, H. L	M.	56
Cooper, K. F	Assoc. M.	168
Cooper, S. L	M.	56
Cooper, T	M.	56
Cope, E. L	Jun.	250
Copeland, F. L	Jun.	250
Copeland, W. R	Assoc.	238
Copland, A. C	Assoc. M.	168
Copley, G. N	Assoc. M.	168
Corby, C. E	Assoc. M.	168
Corey, R. H	Assoc. M.	168
Corlett, B. E	Assoc. M.	168
Cornell, D	Assoc. M.	168
Cornell, G. B	M.	56
Cornell, J. N. H	M.	56
Corner, C	M.	57
Corning, D. T	Assoc. M.	168
Cornish, L. D	Assoc. M.	168
Coroalles, M. A	M.	57
Corp, H. W	Jun.	250
Corrigan, G. W	Assoc. M.	168
Corry, T. A	M.	57
Corthell, A. B	M.	57
Corthell, E. L	M.	57
Corti, J. J	Assoc. M.	168
Cortright, E. K	Jun.	250
Cory, H. T	M.	57
Cosby, S	M.	57
Cother, A. A	Assoc. M.	168
Cothran, T. W	Assoc. M.	168
Cotton, J. P	M.	57
Cotton, M. P	Jun.	250
Couchot, M. C	M.	57

Page
Coulson, B. LeF. Assoc. M. 169
Coulter, W. S. Assoc. M. 169
County, A. J. Assoc. 238
Courtenay, W. H. M. 57
Coutlee, C. R. F. M. 57
Covell, V. R. Assoc. M. 169
Coverdale, W. H. Assoc. M. 169
Covert, C. C. Assoc. M. 169
Cowan, H. W. M. 57
Cowles, L. S. Assoc. M. 169
Cowles, W. L. M. 57
Cowles, W. P. Assoc. M. 169
Cowper, J. W. Assoc. M. 169
Coyne, H. L Jun. 250
Cox, L. M. M. 57
Craig, G. W. Assoc. M. 169
Craig, P. I Assoc. M. 169
Craig, W. R. Assoc. M. 169
Crain, A. M Assoc. M. 169
Crandall, C. Lee M. 57
Crandall, C. Leo M. 57
Crane, A. S. M. 57
Crane, C. A M. 57
Crane, F. E. M. 57
Crane, J. S. Assoc. M. 169
Crane, W. E. Jun. 250
Craven, A. M. 57
Crawford, J. E. M. 57
Crawford, W. M. 57
Crawley, E. W. Jun. 250
Crecelius, S. F. M. 57
Creelman, C. L. Assoc. M. 169
Crehore, W. W. M. 58
Crellin, E. W M. 58
Cresson, B. F., Jr. M. 58
Creuzbaur, R. W. M. 58
Crew, C. C. M. 58
Crider, J. L M. 58
Crisp, E. J. Assoc. M. 169
Crocker, H. S. M. 58
Crook, J. A. Assoc. M. 169
Crooks, C. H. Jun. 250
Crosby, B. L. M. 58
Crosby, Hewitt Assoc. M. 169
Crosby, Horace M. 58
Crosby, W. W. M. 58
Crosett, J. H. Assoc. M. 169
Croswell, T. H. M. 58

Page
Crow, E. Jun. 250
Crowell, F. M. 58
Crowell, F. S. Jun. 250
Crozier, W. M. 58
Crump, R. L. M. 58
Cryder, H. M Assoc. M. 169
Crysler, A. G. Assoc. M. 169
Cuddeback, A. W. Assoc. M. 169
Cudworth, F. G. Assoc. M. 169
Culgin, G. W. Assoc. M. 170
Cullen, J. F. M. 58
Cummings, E. D. Assoc. M. 170
Cummings, N Assoc. M. 170
Cummings, R. A. M. 58
Cummings, W. W. M. 58
Cunningham, A. C. M. 58
Cunningham, A. O. M. 58
Cunningham, D. W. M. 58
Cunningham, E. W. Assoc. M. 170
Cunningham, J. E. Jun. 250
Cunningham, J. G. L. Assoc. M. 170
Cunningham, James H M. 58
Cunningham, Joseph H. M. 59
Cunningham, J. W Jun. 251
Cunningham, P. E. Jun. 251
Cunningham, S., Jr. Assoc. M. 170
Currier, C. G. Assoc. 238
Curtis, C. A Assoc. M. 170
Curtis, C. E. M. 59
Curtis, F. S. M. 59
Curtis, L. B. Assoc. M. 170
Curtis, V. P. Assoc. M. 170
Curtis, W. W M. 59
Cushing, E. B. M. 59
Cushing, W. C. M. 59
Cushman, A. S Assoc. 238
Cushman, W. H. M. 59
Cutler, S. G. Jun. 251

Dabney, A. L. M. 59
Dabney, T. G. M. 59
Daggett, F. W. Assoc. M. 170
Daggett, H. C. M. 59
Dahm, S. M. 59
Dailey, J. A. Assoc. 238
Dakin, A. H., Jr. M. 59
Dallis, P. A M. 59
Dalrymple, F. W. Assoc. M. 170

Page

Dalton, B. J.......M. 59
Dana, R. T.......M. 59
Danforth, F.......M. 59
Danforth, R. E.......M 59
Daniels, M. R.......Assoc. M. 170
Daniels, T. R. H.......Assoc. M. 170
Dann, A. W.......Jun. 251
Darling, F. S.......M. 59
Darling, J. H.......M. 59
Darling, J. W.......Assoc. M. 170
Darling, W. L.......M. 59
Darrach, C. G.......M. 59
Darrow, F. T.......M. 59
Darrow, M. S.......Assoc. M. 170
Darrow, W. J.......Assoc. M. 170
Dart, C. R.......M. 60
Dart, J. V.......M. 60
Darwin, H. G.......F. 274
Darwin, W. P.......Assoc. M. 170
Dater, P. H.......Assoc. M. 170
Datesman, G. E.......M. 60
Dauchy, W. E.......M. 60
Daugherty, H. M.......Assoc. M. 170
Davenport, J. A.......M. 60
Davenport, J. W.......Assoc. M. 170
Davidson, F. E.......M. 60
Davidson, G.......Hon. M. 33
Davies, J. V.......M. 60
Davies, W. G.......Assoc. M. 170
Davis, A. L.......M. 60
Davis, A. P.......M. 60
Davis, B. H.......Assoc. M. 171
Davis, C.......M. 60
Davis, C. B.......M. 60
Davis, C. E.......M. 60
Davis, C. E. L. B.......M. 60
Davis, C. H.......M. 60
Davis, C. M.......Jun. 251
Davis, C. S.......M. 60
Davis, F.......Assoc. M. 171
Davis, F. C.......Assoc. M. 171
Davis, F. R.......Assoc. M. 171
Davis, G. J., Jr.......Assoc. M. 171
Davis, G. L.......Assoc. M. 171
Davis, G. R.......Assoc. M. 171
Davis, G. W.......Jun. 251
Davis, H.......Assoc. M. 171
Davis, J. B.......M. 60

Page

Davis, J. C.......Assoc. M. 171
Davis, J. L.......Assoc. M. 171
Davis, J. P.......M. 60
Davis, J. R. W.......M. 60
Davis, L. H.......M. 60
Davis, L. LeR.......M. 60
Davis, N. W.......M. 60
Davis, R. B.......M. 60
Davis, W. R.......Assoc. M. 171
Davison, G. S.......M. 61
Davoud, V. Y.......Assoc. M. 171
Dawley, E. P.......M. 61
Dawley, W. S.......M. 61
Dawson, E. F.......M. 61
Day, E. B.......Assoc. M. 171
Day, W. P.......Jun. 251
Deacon, E. F.......Assoc. M. 171
Dean, A. W.......M. 61
Dean, B. D.......M. 61
Dean, L.......M. 61
Dean, S.......Assoc. M. 171
Deans, J. S.......M. 61
DeBerard, W. W.......Assoc. M. 171
Decker, A. J.......Jun. 251
Decker, J. H.......Assoc. M. 171
Deen, J. W.......M. 61
de Forest, N. B.......Jun. 251
Defrees, M. M.......M. 61
DeGraff, H. W.......Assoc. M. 171
de Gratresse, J. R.......Assoc. M. 171
de la Barre, W.......M. 61
De La Mater, S. T.......Assoc. M. 171
Delano, F. A.......M. 61
DeMott, C. L.......Assoc. M. 171
Dempster, O. J.......Assoc. M. 171
Dencer, F. W.......M. 61
Denio, G. La P.......Assoc. 238
Dennie, F. E.......Jun. 251
Dennis, A. C.......M. 61
Dennis, H. W.......Assoc. M. 171
Dennis, W. F.......M. 61
Densler, F. H.......Jun. 251
Dent, E. J.......Assoc. M. 172
Dent, W. D.......Assoc. M. 172
Derby, C. C.......Assoc. M. 172
Derby, G. McC.......M. 61
Derleth, C., Jr.......M. 61
Derleth, W. T.......Jun. 251

		Page
Derr, H. M.	Assoc. M.	172
Derrick, H. C	M.	61
Deutschbein, H. J	Jun.	251
de Varona, I. M.	M.	61
Develin, R. G	M.	61
Devin, G.	M.	61
Devlin, H. S	Assoc. M.	172
de Vou, J. L	Assoc. M.	172
De Witt, P. H.	M.	61
Deyo, S. L. F	M.	61
De Young, I.	M.	62
Dewey, C. E.	Assoc.	238
de Wyrall, C	Assoc.	238
Diamant, A. H	Assoc. M.	172
Dibert, H. McM	Jun.	251
Dicke, E. C	Assoc. M.	172
Didier, P.	M.	62
Diebitsch, E	M.	62
Dieck, R. G	Assoc. M.	172
Dieden, G. V.	Assoc. M.	172
Diehl, D. L	Assoc. M.	172
Diehr, A. B.	M.	62
Dilks, L. C	Assoc. M.	172
Dillard, J. L	Assoc. M.	172
Dillenbeck, C	M.	62
Dillman, G. L	M.	62
Dillon, F. H	Assoc. M.	172
Dimmler, C. L	Jun.	251
Dimon, D. Y.	M.	62
Dingle, J. H	Assoc. M.	172
Diven, J. M	Assoc.	238
Dixon, C. Y	M.	62
Dixon, De F. H.	Assoc. M.	172
Doane, W. A	M.	62
Doble, W. A	M.	62
Dobson, A.	M.	62
Dockweiler, J. H	M.	62
Dodd, A. B.	Assoc. M.	172
Dodd, J. H	Assoc. M.	172
Dodge, J. L.	M.	62
Dodge, S. D	Assoc. M.	172
Doe, C. L.	Jun.	251
Doebler, V. S	Assoc. M.	172
Doerfling, R. G	M.	62
Domenech, M. V.	M.	62
Donahey, J. A	Assoc. M.	172
Donald, R. L'A.	Assoc. M.	173
Donham, B. C	M.	62
Donovan, C.	M.	62
Donovan, J. J.	M.	62
Doremus, A. F	M.	62
Dorr, E. S.	M.	62
Dorrance, F. Y	Jun.	251
Dorrance, W. T.	Assoc. M.	173
Dorsey, L	Assoc. M.	173
Dorsey, W. H	Assoc. M.	173
Dose, H. F.	M.	62
dos Santos, J. A.	M.	63
Doten, L. S.	Assoc. M.	173
Doty, J. W.	Assoc. M.	173
Dougan, J.	Assoc. M.	173
Dougan, W. T.	M.	63
Dougherty, R. E	Jun.	251
Douglas, B	M.	63
Douglas, E. M.	M.	63
Douglas, W. J.	M.	63
Douglass, A. C.	Assoc.	238
Dow, A.	M.	63
Downer, T. B.	Assoc. M.	173
Downes, A. K.	Assoc. M.	173
Downey, A. S.	M.	63
Downman, J. R.	Assoc. M.	173
Doyle, H. S	Assoc. M.	173
Doyle, J. S.	Assoc. M.	173
Drake, A. B	M.	63
Drake, R. M.	Assoc. M.	173
Drake, W. A.	M.	63
Drane, B. S.	Assoc. M.	173
Drew, C. D.	Assoc. M.	173
Driggs, E. L.	Jun.	251
Drowne, H. B.	Assoc. M.	173
Drummond, T. J.	Assoc.	238
Drury, E. H.	M.	63
Du Bois, A. J.	M.	63
Dubois, G. A.	Jun.	251
Du Bois, J.	Assoc. M.	173
Duder, J.	Assoc. M.	173
Duffies, E. J.	M.	63
Dufour, F. O.	Assoc. M.	173
Duggan, G. H.	M.	63
Duis, F. B.	Assoc. M.	173
Dunan, G. E.	Jun.	251
Duncan, J. H.	Assoc. M.	173
Duncan, L.	M.	63
Duncklee, J. B.	M.	63
Dunham, H. F	M.	63

		Page
Dunham, L. A.	M.	63
Dunham, W. R., Jr.	M.	63
Dunlap, De C.	M.	63
Dunlap, F. C	M.	63
Dunmire, E. H	Jun.	251
Dunn, D. B	M.	63
Dunn, E. C	Assoc. M.	173
Dunn, H. L	Assoc. M.	173
Dunn, W. R	Assoc. M.	173
Dunnells, C. G	Assoc. M.	174
du Pont, B	F.	274
Durham, H. W	M.	63
Duryea, E., Jr.	M.	63
Dutton, C. H	Assoc. M.	174
Dyer, A. J	M.	63
Eames, H. L	Jun.	252
Earl, A. W	Jun.	252
Earl, G. G	M.	64
Earle, F. H., Jr	Jun.	252
Earle, T	M.	64
Easby, M. W	M.	64
Easby, W., Jr	M.	64
Easterbrook, F. J	M.	64
Easterbrooks, P. B	Assoc. M.	174
Easton, R. B	Jun.	252
Eastwood, J. T	M.	64
Eaton, F	M.	64
Eavenson, H. N	M.	64
Eber, J. W	Assoc. M.	174
Eberspacher, F	Jun.	252
Eckart, N. A	Assoc. M.	174
Eckart, W. R	M.	64
Eckel, E. C	Assoc.	239
Eckersley, J. O	M.	64
Eddy, C. W	Assoc. M.	174
Eddy, H. P	M.	64
Edelen, T. J. S	Assoc. M.	174
Eder, H. J	Assoc. M.	174
Edes, W. C	M.	64
Edgerton, G. E	Jun.	252
Edmundson, H. B	Jun.	252
Edwards, C. M	Assoc. M.	174
Edwards, D. G	Jun.	252
Edwards, F	Assoc. M.	174
Edwards, H. W	M.	64
Edwards, J. H	M.	64
Edwards, O. C., Jr.	Assoc. M.	174
Edwards, W. R	Assoc. M.	174
Egan, L. H	Assoc. M.	174
Eglee, C. H	Assoc.	239
Ehle, B	M.	64
Ehrbar, L. H	Assoc. M.	174
Eidlitz, O. M	M.	64
Eitzen, A. R	Jun.	252
Elam, W. E	Jun.	252
Elbury, T. G	Assoc. M.	174
Eld, C. J., Jr.	Assoc. M.	174
Eldridge, C	M.	64
Eldridge, G. M	M.	64
Ellery, N	M.	64
Elliott, C. G	M.	64
Elliott, H	Assoc.	239
Elliott, J. R	M.	64
Elliott, J. S	Assoc. M.	174
Elliott, J. W	Assoc. M.	174
Elliott, M	Assoc. M.	174
Ellis, C. A	Assoc. M.	174
Ellis, G. E	M.	64
Ellis, G. W	Assoc. M.	174
Ellis, J. W	M.	65
Ellis, S. C	M.	65
Ellsworth, E. A	M.	65
Ellsworth, L	Jun.	252
Elmer, H. N	M.	65
Elrod, H. E	Assoc. M.	175
Eltinge, O. L	Jun.	252
Elwell, C. C	M.	65
Ely, C. B.	Assoc. M.	175
Ely, J. A.	Assoc. M.	175
Ely, J. S	Assoc. M.	175
Ely, T. N	M.	65
Emerson, G. C	M.	65
Emerson, G. D	Assoc. M.	175
Emery, J. A	M.	65
Emig, J. W	M.	65
Emmons, C. M	M.	65
Emory, L. T	Jun.	252
Endemann, H. K	M.	65
Endicott, M. T	M.	65
Endo, T	M.	65
Engle, C. A	Assoc. M.	175
Engström, F	Assoc. M.	175
Eno, F. H	M.	65
Ensign, G. W	Assoc. M.	175
Enzian, C	Assoc. M.	175

		Page
Erdmann, E. E	Jun.	252
Ericson, J. E	M.	65
Erlandsen, O	M.	65
Ernst, O. H	M.	65
Espenshade, E. B	Assoc. M.	175
Esselstyn, H. H	M.	65
Estabrook, G. M	Jun.	252
Esten, H. F	Jun.	252
Estes, F. E	Assoc. M.	175
Etcheverry, B. A	Assoc. M.	175
Evans, E. G	M.	65
Evans, J. E	Assoc. M.	175
Evans, J. M	Assoc. M.	175
Evans, L. H	M.	65
Evans, P. P	Assoc. M.	175
Evans, R	M.	65
Evans, R. R	M.	65
Everest, C. M	F.	274
Everham, A. C	Assoc. M.	175
Ewen, J. M	M.	65
Ewing, W. B	M.	65
Ewing, W. R	Jun.	252
Ewing, W. W	M.	66

		Page
Fain, J. R	Assoc. M.	175
Fairchild, J. F	Assoc. M.	175
Fairchild, S. E., Jr	M.	66
Fairleigh, J. A	M.	66
Falk, M. S	M.	66
Falter, P. H	Assoc. M.	175
Fanning, J. T	M.	66
Fargo, W. G	M.	66
Farley, G. P	M.	66
Farley, J. M	M.	66
Farley, M. M	Jun.	252
Farley, P. P	M.	66
Farley, W. S	Assoc. M.	175
Farnham, A. B	Assoc. M.	175
Farnham, C. H	Assoc. M.	175
Farnham, R., Jr	Assoc. M.	176
Farnum, H. H	M.	66
Farnum, L. N	M.	66
Farquhar, H. S	Assoc. M.	176
Farrar, H. P	M.	66
Farrell, E. J	Assoc.	239
Farren, B. N	F.	274
Farrin, J. M	Assoc. M.	176
Farrington, H	M.	66
Faucette, W. D	Jun.	252
Fauntleroy, J. D	M.	66
Fay, E. B	M.	66
Fay, F. H	M.	66
Federlein, W. G	Assoc. M.	176
Fehr, H. R	M.	66
Feigel, J. H	Jun.	252
Felgenhauer, F. J	Jun.	252
Felt, C. F. W	M.	66
Feltham, P. M	M.	66
Felton, B. R	M.	67
Felton, H. C	M.	67
Felton, S. M	M.	67
Fendall, B. T	M.	67
Fenkell, G. H	M.	67
Fenkell, N. C	Assoc. M.	176
Fenn, R. W	M.	67
Fenn, W. H	M.	67
Fenstermaker, DeW. C.	Assoc. M.	176
Fenton, L. G	Assoc. M.	176
Ferguson, G. R	M.	67
Ferguson, H. S	M.	67
Ferguson, J. B	M.	67
Ferguson, J. E	Assoc. M.	176
Ferguson, J. N	M.	67
Ferguson, J. W	M.	67
Ferguson, L. R	Jun.	252
Ferguson, W. H	Assoc. M.	176
Fernald, C. T	M.	67
Fernstrom, H	M.	67
Ferradas, R	Assoc. M.	176
Ferrier, J. J	Jun.	252
Ferris, F. E	Assoc. M.	176
Ferris, J. J	Assoc.	239
Ferry, C. A	M.	67
Fertig, J. H	Jun.	252
Fetherston, J. T	M.	67
Feustel, R. M	Jun.	252
Fickes, C. R	M.	67
Fickes, E. S	M.	67
Fiebeger, G. J	M.	67
Field, C. H	Jun.	253
Field, F. E	Assoc. M.	176
Field, G. R	M.	68
Field, G. S	M.	68
Field, J. E	M.	68
Field, W. P	M.	68

		Page
Fields, S. J	M.	68
Finch, J. K	Jun.	253
Finch, S. P	Jun.	253
Fineren, W. W	Assoc. M.	176
Fink, R	M.	68
Finley, E. C	M.	68
Finley, W. H	M.	68
Firmstone, F	M.	68
Firth, E. W	Assoc. M.	176
Firth, J	Assoc. M.	176
Fischer, G. G	Jun.	253
Fischer, T. C	Assoc. M.	176
Fish, J. C. L	M.	68
Fishburne, E. B., Jr	Assoc.	239
Fisher, C. C	Assoc. M.	176
Fisher, E. A	M.	68
Fisher, F. D	M.	68
Fisher, H. T	Assoc. M.	176
Fisher, J	M.	68
Fisher, S. B	M.	68
Fisher, W	Assoc. M.	176
Fisher, W. H	Jun.	253
Fisk, C. H	Assoc. M.	176
Fisk, W. C	Assoc.	239
Fisk, W. L	M.	68
Fitch, A. B	M.	68
Fitch, C. H	M.	68
Fitch, C. L	M.	68
Fitch, G. D	M.	68
Fitch, H. A	M.	68
Fitch, S. E	Assoc. M.	176
FitzGerald, C. C	Assoc. M.	176
FitzGerald, D.	M.	68
FitzGerald, J. L	M.	68
FitzRandolph, W. S	Jun.	253
Flad, E	M.	68
Flagg, J. F	M.	68
Fleming, H. B	M.	68
Fleming, S	M.	69
Fleming, T., Jr	Assoc. M.	176
Fletcher, A. B	M.	69
Fletcher, J. M	Assoc. M.	176
Fletcher, R	M.	69
Flinn, A. D	M.	69
Flint, C. R	F.	274
Floesch, J. M	M.	69
Flynn, J., Jr	M.	69
Follett, W. W	M.	69
Folwell, A. P	M.	69
Focht, L	Assoc. M.	177
Fogg, P. M	Assoc. M.	177
Follansbee, R	Assoc. M.	177
Foote, A. B	Assoc. M.	177
Foote, A. DeW	M.	69
Forbes, M.	Assoc. M.	177
Force, C. G	M.	69
Forchhammer, H. T	Assoc. M.	177
Ford, F. L	M.	69
Ford, Harry C	Jun.	253
Ford, Howard C	Jun.	253
Ford, P. D	M.	69
Ford, R. H. P	Assoc. M.	177
Ford, T. B	M.	69
Ford, W. G	M.	69
Ford, W. H	M.	69
Forgie, J	M.	69
Forrest, C. N	Assoc. M.	177
Forrest, G. M	Assoc. M.	177
Forsyth, H. F	Jun.	253
Forsyth, R	M.	69
Fort, E. J	M.	69
Fortin, S. J	M.	69
Fortney, C. P	Assoc. M.	177
Foss, F. E.	M.	69
Foss, J. C., Jr	Jun.	253
Foss, J. H	Jun.	253
Foss, W. E	M.	69
Foster, C. M	Assoc.	239
Foster, E. H	M.	70
Foster, H. B	Jun.	253
Foster, M	Assoc. M.	177
Foster, T. J	Assoc. M.	177
Foster, W. F	M.	70
Fougner, H	Assoc. M.	177
Foulds, R. S	Jun.	253
Fountain, T. L	Assoc. M.	177
Fouquet, J. D	M.	70
Fowler, C. E	M.	70
Fowler, F. G	Assoc. M.	177
Fowler, F. H	Jun.	253
Fowler, R. L	Assoc. M.	177
Fowler, T. W	M.	70
Fox, C. L	Jun.	253
Fox, D	Hon. M.	33
Fox, H	M.	70
Fox, J. A	M.	70

Page
Fox, S. W. .... M. 70
Fox, W. G. .... Assoc. M. 177
Foyé, A. E. .... Assoc. M. 177
Francis, C. .... M. 70
Francis, G. B. .... M. 70
Francis, H. N. .... M. 70
Francis, W. J. .... M. 70
Franklin, B. .... M. 70
Fraser, C. E. .... M. 70
Frasquieri y Regueifero, T.,
Assoc. M. 177
Frazee, J. H. .... Assoc. M. 177
Frazer, J. H. .... Jun. 253
Frazer, J. S. .... Jun. 253
Frazier, H. .... M. 70
Frazier, J. L. .... M. 70
Frazier, J. W. .... M. 70
Freeland, C. S. .... M. 70
Freeman, A. C., Jr. .... Assoc. M. 177
Freeman, J. R. .... M. 70
Freeman, M. H. .... Assoc. M. 177
Freitag, J. K. .... Assoc. M. 177
French, A. H. .... M. 70
French, A. W. .... M. 71
French, C. R. .... Assoc. M. 177
French, F. C. .... M. 71
French, J. A. .... M. 71
French, J. B. .... M. 71
French, M. J. .... Assoc. M. 177
French, O. B. .... M. 71
French, R. DeL. .... Jun. 253
Frew, A. S. .... M. 71
Frew, R. D. A. .... Assoc. M. 178
Frey, F. E. .... Assoc. M. 178
Freyhold, F. .... M. 71
Frick, W. .... Assoc. M. 178
Frickstad, W. N. .... Assoc. M. 178
Frink, E. A. .... M. 71
Frink, F. G. .... Assoc. M. 178
Frisell, E. H. .... Assoc. M. 178
Fritch, L. C. .... M. 71
Fritz, J. .... Hon. M. 33
Frizell, J. P. .... M. 71
Frosell, C. G. .... M. 71
Frost, G. H. .... Assoc. 239
Frost, G. S. .... Assoc. M. 178
Fruit, J. C. .... Assoc. M. 178
Frye, A. I. .... M. 71
Frye, H. E. .... Assoc. M. 178
Fryer, H. Le R. .... Jun. 253
Fucik, E. J. .... Assoc. M. 178
Fuertes, J. H. .... M. 71
Fuller, A. D. .... Assoc. M. 178
Fuller, A. H. .... Assoc. 239
Fuller, C. H. .... Assoc. M. 178
Fuller, F. I. .... M. 71
Fuller, F. L. .... M. 71
Fuller, G. W. .... M. 71
Fuller, H. .... M. 71
Fuller, W. B. .... M. 71
Fuller, W. E. .... Assoc. M. 178
Fulton, J. A. .... M. 71
Furber, W. C. .... M. 71
Furlow, F. .... Assoc. M. 178
Furman, J. R. .... M. 71
Futami, K. .... Assoc. 239
Fyfe, J. L. .... M. 72

Gadsden, G. M. .... M. 72
Gagel, E. .... M. 72
Gahagan, W. H. .... M. 72
Gaiger, F. M. .... Jun. 253
Gaines, F. L. .... Assoc. 239
Galbreath, W. O. ...... Assoc. M. 178
Galloway, J. D. .... M. 72
Galvin, J. A. .... Jun. 253
Gamble, F. C. .... M. 72
Gandolfo, J. H. .... Assoc. M. 178
Gannett, F. .... Assoc. M. 178
Gardiner, F. W. .... M. 72
Gardiner, J. P. .... Assoc. M. 178
Gardner, E. LeB. .... M. 72
Gardner, H. C. .... Jun. 253
Gardner, M. L. .... M. 72
Gardner, R. D. .... Assoc. M. 178
Gardner, W. M. .... M. 72
Garlinghouse, F. L. .... M. 72
Garman, H. O. .... Assoc. M. 178
Garrett, J. E. .... M. 72
Garrett, J. T. .... Assoc. M. 178
Garrett, R. P. .... M. 72
Garrigues, H. H. .... Jun. 253
Garrison, E. .... M. 72
Garrison, F. L. .... M. 72
Gartensteig, C. .... Assoc. M. 179
Garvin, E. C. .... Jun. 253

		Page
Gast, E. A	Jun.	253
Gaston, L. P	M.	72
Gates, C. L	M.	72
Gates, H. D	M.	72
Gates, M. DeM	Jun.	254
Gault, H. J.	M.	72
Gaut, R. E	M.	72
Gay, C. W	M.	72
Gay, L. L	Assoc. M.	179
Gay, M	M.	73
Gay, R. W	Jun.	254
Gayler, C	M.	73
Gayler, E. R	Assoc. M.	179
Gaylord, L. T	Assoc. M.	179
Gayol, R	M.	73
Gazlay, W.	M.	73
Gearhart, H. G	Jun.	254
Gearhart, W. S	Assoc. M.	179
Geddes, E. B	M.	73
Geddes, J. K	M.	73
Geer, H. M	M.	73
Gellatly, J. T. B	Assoc. M.	179
Gemmell, R. C	M.	73
Gentner, O. H., Jr	Assoc. M.	179
Gerber, E	M.	73
Gerig, W.	M.	73
Germer, W. E	Jun.	254
Gerry, M. H., Jr	M.	73
Gersbach, E. C	Assoc. M.	179
Gessner, G. A., Jr	M.	73
Getman, F. L	M.	73
Gibbs, E. A	Assoc. M.	179
Gibbs, G	M.	73
Gibson, W. L.	Assoc. M.	179
Giddings, F	M.	73
Gideon, A	Assoc. M.	179
Gifford, G. E	M.	73
Gifford, G. H	Jun.	254
Gifford, L. R	Assoc. M.	179
Gifford, R. L	M.	73
Gilbert, A. M	Assoc. M.	179
Gilbert, G. H	Assoc. M.	179
Gildersleeve, A. C	Assoc.	239
Gildersleeve, G. S	Assoc. M.	179
Giles, A. L	Assoc. M.	179
Giles, J. M	Assoc. M.	179
Giles, R	M.	73
Gilfillan, G. A	M.	73
Gilkey, T. A	Assoc. M.	179
Gilland, T. O	Jun.	254
Gillelen, F	Jun.	254
Gillen, W. J	Assoc. M.	179
Gillespie, R. H	M.	73
Gillette, E	M.	73
Gillette, H. P	M.	74
Gillette, L. S	M.	74
Gillham, P. D	Jun.	254
Gilman, C	Jun.	254
Gilman, C. E	Assoc. M.	179
Gilman, J. B	M.	74
Gilmore, A. L	Jun.	254
Giquel, R. S	Jun.	254
Gladding, H. H	M.	74
Glasgow, A. G	M.	74
Glazier, W. L	M.	74
Gleim, C. O	Cor. M.	33
Goad, C. E	M.	74
Goddard, H. W	Assoc. M.	180
Goddard, L. W	M.	74
Godfrey, E	M.	74
Going, A. S	M.	74
Goldenberg, M	Assoc. M.	180
Goldmark, H	M.	74
Goldsborough, J. B	Assoc.	239
Goldsmith, N. O	Assoc. M.	180
Goodale, L. F	M.	74
Goodell, J. M	Assoc.	239
Goodell, J. S	Assoc. M.	180
Goodman, H. M	Jun.	254
Goodman, J	Assoc. M.	180
Goodman, L	Assoc. M.	180
Goodnough, X. H	M.	74
Goodrich, E. P	M.	74
Goodrich, T. M	Jun.	254
Goodrich, W. F	M.	74
Goodridge, J. W	Assoc. M.	180
Goodsell, D. B	Assoc. M.	180
Goodwin, G. E	M.	74
Goodwin, I. D	Jun.	254
Goodwin, J. B	M.	74
Gordon, C. E	M.	74
Gordon, J. B	Assoc. M.	180
Gotshall, W. C	M.	74
Gotwals, J. C	Jun.	254
Gough, W. J	Assoc. M.	180
Gould, C. M	Jun.	254

		Page
Gould, H. M.	M.	74
Gould, J. W. Du B.	Jun.	254
Gould, W. T	M.	75
Gove, W. G	M.	75
Govern, E. J	M.	75
Gow, C. R	Assoc. M.	180
Gowen, S	Assoc. M.	180
Grace, A	M.	75
Grady, C. B	M.	75
Grady, J. E	Assoc. M.	180
Grafton, C. E	M.	75
Graham, C. H	M.	75
Graham, E. M	Assoc. M.	180
Graham, G. P	Jun.	254
Graham, L. D	Jun.	254
Graham, W. W	Assoc.	239
Gram, L. M	Assoc. M.	180
Gram, R. S.	Jun.	254
Granbery, J. H	M.	75
Grant, E. W	M.	75
Grant, J. H	M.	75
Grant, K. C	Assoc. M.	180
Grant, T. H	Assoc. M.	180
Grant, U. S, 3rd	Assoc. M.	180
Grantham, H. T	M.	75
Gravelle, A	Assoc. M.	180
Graves, E. D	M.	75
Graves, E. M	Assoc.	239
Graves, W. F	Assoc. M.	180
Graves, W. H	M.	75
Graves, W. J	M.	75
Gray, E	Assoc. M.	180
Gray, E., Jr	Assoc. M.	180
Gray, G. E	Hon. M.	33
Gray, H. F	Jun.	254
Gray, H. L	Assoc. M.	180
Gray, J. C	Jun.	254
Gray, J. H	M.	75
Gray, J. L	Assoc. M.	181
Gray, S. M	M.	75
Gray, W	Assoc. M.	181
Gray, W. B	Assoc. M.	181
Gray, W. D	Assoc. M.	181
Gray, W. T	Assoc. M.	181
Greathead, J. F	Jun.	254
Greeley, S. A	Jun.	254
Green, A. H.	Assoc. M.	181
Green, B. L	M.	75
Green, B. R	M.	75
Green, C. J	Jun.	254
Green, C. N	Assoc. M.	181
Green, F. M	Assoc. M.	181
Green, F. W	Assoc.	239
Green, H. B	Assoc.	239
Green, H. E	M.	75
Green, J. A	Assoc. M.	181
Green, J. C	Assoc. M.	181
Green, P. E.	Assoc. M.	181
Green, S. Magee	F.	274
Green, S. Martin	M.	75
Greenalch, W	Assoc. M.	181
Greene, A. E	Assoc. M.	181
Greene, C	Assoc. M.	181
Greene, F. I	Jun.	254
Greene, F. S	Assoc. M.	181
Greene, F. V	M.	76
Greene, G. S., Jr	M.	76
Greene, H. A	Assoc. M.	181
Greene, L. W	Jun.	254
Greene, R. M	M.	76
Greene, W. S	Assoc. M.	181
Greenlaw, R. W	Jun.	254
Greenman, R. S.	Assoc. M.	181
Greensfelder, A. P	Assoc. M.	181
Greenwood, A. H	Assoc. M.	181
Gregory, A. C.	Assoc. M.	181
Gregory, C. E.	Assoc. M.	181
Gregory, J. H	M.	76
Gregory, L. E	M.	76
Gregory, W. B	M.	76
Gregson, A. C	Jun.	254
Greiner, J. E	M.	76
Gresham, R. H	M.	76
Griffin, A.	Jun.	255
Griffin, A. J	Assoc. M.	181
Griffin, W. R. W	M.	76
Griffith, J. H	Assoc. M.	181
Griffith, L	Assoc. M.	182
Griggs, J	M.	76
Grimes, E. L	M.	76
Grimm, C. R	M.	76
Grimm, H. E.	Assoc. M.	182
Grimshaw, J. W	M.	76
Grindrod, I. S	Jun.	255
Griswold, H. T	Assoc. M.	182
Griswold, R. E	Assoc. M.	182

		Page
Gronwall, T. H.	Assoc. M.	182
Gross, C. A	Jun.	255
Gross, C. F	Assoc. M.	182
Gross, D. W.	Assoc. M.	182
Gross, J. W.	Jun.	255
Grossart, L. J. H.	M.	76
Grover, N. C.	Assoc. M.	182
Grover, O. L.	Assoc. M.	182
Grunsky, C. E.	M.	76
Gubelman, F. J.	Assoc. M.	182
Gude, A. V., Jr.	Assoc. M.	182
Gudewill, C. E.	Assoc. M.	182
Gudmundsson, G.	Assoc. M.	182
Gueringer, L. A.	Assoc. M.	182
Guise, P	Assoc. M.	182
Gumaer, E. B.	M.	76
Gundersen, A.	Assoc. M.	182
Gunn, W. E.	M.	76
Gunnell, W. C.	M.	76
Guppy, B. W.	M.	76
Gustafson, G. E.	Assoc. M.	182
Gustin, R P.	Assoc. M.	182
Gutelius, F. P.	M.	76
Guthrie, E. B.	M.	76
Guthrie, K. O.	Assoc. M.	182
Haas, E. F.	M.	77
Haas, P. L.	Assoc. M.	182
Hackney, J. W.	M.	77
Hadsall, H. H.	M.	77
Hadsall, J. C.	Assoc. M.	182
Hadwen, T. L. D.	Assoc. M.	182
Haehl, H. L.	Assoc. M.	182
Hagar, E. McK.	Assoc. M.	183
Hager, A. B	Assoc. M.	183
Haggart, C. N.	Assoc. M.	183
Hague, C. A.	M.	77
Haight, H. De R.	Assoc. M.	183
Haight, S. S.	M.	77
Hain, J. C.	Assoc. M.	183
Haines, C. W.	M.	77
Haines, E. G	Assoc. M.	183
Haines, H. S.	M.	77
Hains, P. C.	M.	77
Halcombe, N. M.	Jun.	255
Haldeman, W. S.	Assoc. M.	183
Hale, H. M.	Jun.	255
Hale, R. A.	M.	77
Hale, R. K.	Assoc. M.	183
Hall, B. M.	M.	77
Hall, C. R.	Assoc. M.	183
Hall, H. A.	M.	77
Hall, H. H.	Jun.	255
Hall, J. A	M.	77
Hall, J. L.	M.	77
Hall, J. R.	Jun.	255
Hall, L. W.	Assoc. M.	183
Hall, M. W.	Assoc. M.	183
Hall, R. E.	Jun.	255
Hall, W. E.	Jun.	255
Hall, W. H.	M.	77
Hall, W. McL.	M.	77
Hallihan, J. P.	M.	77
Hallock, J. C.	M.	77
Hallsted, J. C.	M.	77
Halsey, E. R.	Assoc. M.	183
Halsey, W. H.	Jun.	255
Ham, W. H.	M.	77
Hambleton, F. H.	M.	77
Hamill, A. S.	Assoc. M.	183
Hamilton, E. P.	Jun.	255
Hamilton, F. P.	Assoc. M.	183
Hamilton, J. W.	M.	77
Hamilton, W. G.	M.	77
Hamlin, G. H.	M.	77
Hamlin, H.	M.	77
Hamlin, H. P.	Jun.	255
Hamlin, R	Assoc. M.	183
Hammatt, E. A. W.	M.	78
Hammatt, W. C.	M.	78
Hammer, R. H.	Jun.	255
Hammond, A. J.	M.	78
Hammond, C. A.	M.	78
Hammond, G. T.	M.	78
Hammond, J. F.	M.	78
Hanavan, W. L	Jun.	255
Hancock, H. S., Jr.	Jun.	255
Hancock, L. W.	Assoc. M.	183
Hancock, R. R.	M.	78
Hand, F. C	M.	78
Hand, R.	Jun.	255
Handbury, T. H.	M.	78
Haney, L. T.	Assoc. M.	183
Hanna, J. H.	M.	78
Hanna, J. V	M.	78
Hanna, W. S.	Assoc. M.	183

		Page
Hansel, C.	M.	78
Hansell, W. A	Assoc. M.	183
Hansen, P.	Assoc. M.	183
Hara Aiyar, N. P.	M.	78
Harahan, W. J.	M.	78
Harbeck, H. R	Assoc. M.	183
Harby, I.	Assoc. M.	184
Hardaway, B. H	M.	78
Hardee, W. J	M.	78
Hardesty, J. R.	Assoc. M.	184
Hardesty, S.	Jun.	255
Hardin, A. T	Assoc. M.	184
Harding, C	M.	78
Harding, H.	M.	78
Harding, J. J	M.	78
Harding, R. J.	Assoc. M.	184
Harding, S. T.	Jun.	255
Harding, W. S	Assoc. M.	184
Hardison, A. C	Assoc. M.	184
Hardman, R. C	Assoc. M.	184
Hardt, C. W	Assoc. M.	184
Hardwicke, A. H. G.	Assoc.	239
Hardy, E. D	M.	78
Hardy, G. F	M.	78
Hardy, H.	M.	78
Haring, A	M.	79
Haring, J. S.	M.	79
Harkness, G. E	M.	79
Harley A. F.	M.	79
Harlow, G. R.	M.	79
Harlow, J. H.	M.	79
Harlow, J. H., Jr.	Assoc. M.	184
Harman, E. L	M.	79
Harman, J. A.	Assoc. M.	184
Harper, E. A.	M.	79
Harper, F. C	Jun.	255
Harper, I. O.	Assoc. M.	184
Harper, J. L	M.	79
Harper, S. O.	Jun.	255
Harps, H. M	Assoc. M.	184
Harrington, A. C.	Assoc. M.	184
Harrington, E	M.	79
Harrington, F. B.	Assoc. M.	184
Harrington, F. F	M.	79
Harrington, H. G.	Assoc. M.	184
Harrington, J. L.	M.	79
Harris, B. B.	Assoc. M.	184
Harris, E. G	M.	79
Harris, G. W.	Assoc. M.	184
Harris, H. A.	Assoc. M.	184
Harris, J. B	Assoc. M.	184
Harris, S.	M.	79
Harris, V. A.	M.	79
Harrison, C. L.	M.	79
Harrison, E. P. H.	M.	79
Harrison, E. W.	M.	79
Harrison, L. B.	Assoc.	239
Harrison, R. E.	Jun.	255
Harrod, B. M.	M.	79
Harroun, P. E.	M.	79
Harshbarger, E. D.	Assoc. M.	184
Hart, R. C	Assoc. M.	184
Harte, C. R.	M.	79
Hartigan, F. L.	M.	79
Hartman, A. F	Assoc. M.	185
Hartman, A. H.	Assoc. M.	185
Hartman, R. T.	Assoc. M.	185
Hartmann, E F.	Assoc.	239
Hartranft, W. G	Assoc.	240
Hartrick, E. M.	M.	80
Harts, W. W.	M.	80
Hartwell, H	M.	80
Hartwell, H. C.	M.	80
Harvey, M. S	Jun.	255
Harwi, S. J.	Jun.	255
Harwood, G. A.	M.	80
Hasbrouck, C. A.	M.	80
Hasbrouck, O.	Assoc. M.	185
Haselton, G.	Jun.	255
Haselwood, F. W.	Jun.	255
Haskell, E. E.	M.	80
Haskell, F. H.	Assoc. M.	185
Haskins, W. J.	M.	80
Haslam, E. E.	M.	80
Hasskarl, J. F.	M.	80
Hastings, F. A.	Assoc. M.	185
Hastings, H. B.	Jun.	256
Hatch, E. H	Jun.	256
Hatch, F. N.	Jun.	256
Hatch, F. T.	M.	80
Hatch, J. N	M.	80
Hathaway, C. M.	Jun.	256
Hatt, W. K.	Assoc. M.	185
Hattan, W. C	Assoc. M.	185
Hatton, H. W.	Assoc. M.	185
Hatton, T. C.	M.	80

		Page
Hauck, W.	Assoc. M.	185
Haugh, J. C	M.	80
Haupt, L. M.	M.	80
Haven, W. A.	M.	80
Havens, R. DeW	Assoc. M.	185
Havens, V. LeR	Assoc. M.	185
Haviland, A.	M.	80
Hawes, L. E.	Assoc. M.	185
Hawgood, H	M.	80
Hawkesworth, J.	Assoc. M.	185
Hawkins, I	Assoc. M.	185
Hawks, J. D	M.	80
Hawksley, K. P	M.	80
Hawley, C. B	Jun.	256
Hawley, C. R	Jun.	256
Hawley, G. P.	Assoc. M.	185
Hawley, J. B	M.	80
Hawley, W. C	M.	81
Hawn, R. J	Assoc. M.	185
Hawxhurst, R., Jr	M.	81
Hayden, E. C	Assoc. M.	185
Hayden, J. B	M.	81
Hayden, W. W	M.	81
Hayes, C. E	Jun.	256
Hayes, Edmund	M.	81
Hayes, Edward	M.	81
Hayes, F. E., Jr	Jun.	256
Hayes, G. S	M.	81
Hayes, H. W	M.	81
Hayes, M. D	Assoc. M.	185
Hayes, R. D	Assoc. M.	185
Hayes, S. W	M.	81
Hayford, J. F	M.	81
Haylow, J. H	Assoc. M.	185
Hayman, E. T	Jun.	256
Haynes, C. S	Assoc. M.	185
Haynes, G. A	Assoc. M.	185
Hays, D	Assoc. M.	186
Hays, J. C	Assoc.	240
Hays, J. W	M.	81
Hayt, R. O	Assoc. M.	186
Hayt, S. T., Jr	M.	81
Hayward, H. W	Assoc.	240
Hayward, R. F	M.	81
Haywood, C. E.	Jun.	256
Hazard, E	Assoc. M.	186
Hazard, S.	M.	81
Hazard, W. A	Assoc. M.	186
Hazelton, C. W	M.	81
Hazelton, W. S	Assoc. M.	186
Hazen, A.	M.	81
Hazen, J. V	Assoc.	240
Hazen, R	Jun.	256
Hazen, W. N	M.	81
Hazlehurst, G. B	M.	81
Hazlehurst, J. N	M.	81
Hazlett, R.	Assoc. M.	186
Heald, E. C	Assoc. M.	186
Heald, S. C	M.	81
Healy, J. F	M.	81
Healy, J. R	Assoc.	240
Hebard, R. W	Assoc. M.	186
Heck, N. H	Assoc. M.	186
Heckle, G. R	Assoc. M.	186
Hedden, E. B	Jun.	256
Hedges, S. H	M.	81
Hedrick, I. G	M.	82
Heer, W., Jr	Assoc. M.	186
Hegardt, G. B.	M.	82
Heiges, T. T	Assoc. M.	186
Heilbronner, L. C	Jun.	256
Heindle, W. A	Assoc. M.	186
Heldt, H. L	M.	82
Heller, J. W	Assoc. M.	186
Hemphill, W. L.	Jun.	256
Hench, N. M	M.	82
Henderer, W. O	M.	82
Henderson, A. A	Assoc. M.	186
Henderson, J. B	M.	82
Henderson, J. T	M.	82
Henderson, S. W	Assoc. M.	186
Hendrick, C. W.	M.	82
Hendricks, V. K	Assoc. M.	186
Hengst, R. G	M.	82
Henley, R. D. M	Jun.	256
Henny, D. C	M.	82
Henry, F. M	Assoc. M.	186
Henry, P. W	M.	82
Henry, S. T	Jun.	256
Hepburn, F. T	M.	82
Herbert, A. P	M.	82
Herbert, H. M	M.	82
Hering, R.	M.	82
Hermann, E. A	M.	82
Hermanns, F. E	Assoc. M.	186
Herrick, H. A	M.	82

		Page
Herrick, J. J.	Assoc. M.	186
Herring, J. C.	Assoc. M.	186
Herring, W. E.	M.	82
Herrmann, F. C.	M.	82
Herron, G. M.	Assoc.	240
Herron, J.	M.	82
Herschel, C.	M.	82
Hersey, G. A.	Assoc. M.	186
Hess, J. S.	Jun.	256
Hesse, F.	M.	82
Heuer, W. H.	M.	83
Hewat, H. J.	Assoc. M.	186
Hewes, V. H.	M.	83
Hewett, B. H. M.	M.	83
Hewett, W. S.	M.	83
Hewins, G. S.	M.	83
Hewitt, C. E.	M.	83
Hewitt, G.	Assoc. M.	186
Hickok, H. A.	M.	83
Hider, A.	M.	83
Higgins, C. H.	Assoc. M.	187
Higgins, G.	M.	83
Higgins, H. K.	Assoc. M.	187
Higgins, H. L.	M.	83
Higgins, J. W.	Assoc. M.	187
Higginson, J. Y.	Assoc. M.	187
Highley, L.	Assoc. M.	187
Hilder, F. C.	Jun.	256
Hildreth, J. L., Jr.	Assoc. M.	187
Hilgard, K. E.	M.	83
Hill, A. B.	M.	83
Hill, C.	M.	83
Hill, C. D.	M.	83
Hill, E. A.	Assoc. M.	187
Hill, E. R.	M.	83
Hill, G.	M.	83
Hill, G. S.	Assoc. M.	187
Hill, H. F.	M.	83
Hill, J. E.	M.	83
Hill, J. J.	F.	274
Hill, J. W.	M.	83
Hill, L. C.	M.	83
Hill, S. B.	Jun.	256
Hill, T. W.	Assoc. M.	187
Hill, W. A.	Assoc. M.	187
Hill, W. H.	M.	83
Hill, W. R.	M.	83
Hiller, J. A.	Assoc. M.	187
Hilliard, F. H.	M.	83
Hillman, G. W.	Assoc. M.	187
Hillyer, W. R.	M.	83
Hilton, H. LeG.	Assoc. M.	187
Hilton, J. C.	Assoc. M.	187
Himes, A. J.	M.	84
Himmelwright, A. L. A.	M.	84
Hinckley, H. V.	M.	84
Hinckley, J. F.	M.	84
Hindes, S. G.	M.	84
Hinds, F. A.	M.	84
Hines, H. E.	Jun.	256
Hinman, L. R.	Jun.	256
Hiroi, I.	M.	84
Hirst, A.	Assoc. M.	187
Hitchcock, F. C.	M.	84
Hitchman, J. C.	Assoc. M.	187
Hitt, R.	Jun.	256
Hittell, J. B.	M.	84
Hoad, W. C.	Assoc. M.	187
Hoag, S. W., Jr.	M.	84
Hobby, A. S.	M.	84
Hobson, J.	M.	84
Hocke, J. G.	M.	84
Hodgdon, B. A.	Assoc. M.	187
Hodgdon, F. W.	M.	84
Hodgdon, J. B.	Assoc. M.	187
Hodge, H. S.	M.	84
Hodge, H. W.	M.	84
Hodges, G.	M.	84
Hodges, H. F.	M.	84
Hodgman, B. B.	Jun.	256
Hodgman, H.	Assoc. M.	187
Hoff, O.	M.	84
Hoffman, N. B. K.	M.	84
Hoffman, W. O.	Assoc. M.	187
Hoffmann, R.	M.	85
Hogan, J. P.	Jun.	256
Hogeland, A. H.	M.	85
Hogg, J. B.	M.	85
Hogue, Charles J.	Assoc. M.	187
Hogue, Chester J.	Assoc. M.	188
Hohl, L. J.	M.	85
Hohl, L. L.	Jun.	256
Hoisington, H. M.	Jun.	256
Holbrook, A. R.	Jun.	257
Holbrook, E.	M.	85
Holbrook, F. D.	M.	85

		PAGE
HOLBROOK, F. W. D.	M.	85
HOLBROOK, J. B.	M.	85
HOLBROOK, P.	Assoc. M.	188
HOLBROOK, W	Jun.	257
HOLCOMBE, J. G.	M.	85
HOLDEN, C. A.	Assoc.	240
HOLDEN, E. H.	M.	85
HOLDREGE, H. A.	Assoc. M.	188
HOLGATE, H.	M.	85
HOLLAND, H. K.	Jun.	257
HOLLEY, C. H.	Assoc. M.	188
HOLLEY, H. H.	Assoc. M.	188
HOLLIDAY, A. R.	Assoc. M.	188
HOLLOWAY, A. P.	Jun.	257
HOLLYDAY, R. C.	M.	85
HOLMAN, M. L.	M.	85
HOLMAN, S.	F.	274
HOLMES, E. M.	Assoc. M.	188
HOLMES, F.	Assoc. M.	188
HOLMES, G. D.	M.	85
HOLMES, H. C.	M.	85
HOLMES, R. L.	Jun.	257
HOLT, H. S.	M.	85
HOLT, L. M.	Assoc. M.	188
HOLTSMARK, E	Assoc. M.	188
HOLTZMAN, S. F.	Assoc. M.	188
HOMAN, W. M.	Assoc. M.	188
HOMBERGER, H.	M.	85
HONE, F. DE P.	M.	85
HONENS, F. W.	M.	85
HONNESS, G. G.	Assoc. M.	188
HOOD, H. K.	Assoc. M.	188
HOOD, J. M., Jr.	Assoc. M.	188
HOOD, J. N.	Assoc. M.	188
HOOD, R. H.	M.	86
HOOD, W.	M.	86
HOOK, C. A	M	86
HOOK, G. S.	M.	86
HOOVER, H. C.	M.	86
HOOVER, J. W.	M.	86
HOPKINS, A. L.	Assoc. M.	188
HOPKINS, C. C.	M.	86
HOPKINS, N. F.	Assoc. M.	188
HOPKINS, S. U.	M.	86
HOPPER, J. J.	Jun.	257
HOPSON, E. G	M.	86
HOPSON, E. H.	Jun.	257
HORN, F. C.	M.	86
HORNE, H. W.	Assoc. M.	188
HORNER, W. W.	Jun.	257
HORNSBY, R. W.	M.	86
HORRIGAN, W. J.	Jun.	257
HORSTMAN, J. P.	Assoc. M.	188
HORTENSTINE, H. R.	Assoc. M.	188
HORTON, A. H.	Assoc. M.	189
HORTON, D. F.	Assoc. M.	189
HORTON, G. T.	M.	86
HORTON, H. E.	M.	86
HORTON, J. W.	Jun.	257
HORTON, R. E.	Assoc. M.	189
HORTON, T.	M.	86
HOSMER, G. F.	Assoc. M.	189
HOTCHKISS, C. W.	M.	86
HOTCHKISS, L. J.	M.	86
HOUGH, D. L.	M.	86
HOUGH, F. M.	Assoc. M.	189
HOUGH, U. B.	M.	86
HOUSE, F. E.	M.	86
HOUSTON, G. N.	M.	86
HOVEY, O. E.	M.	86
HOVEY, R. P.	Assoc. M.	189
HOW, R. W.	Assoc. M.	189
HOWALT, W. J. C.	Assoc. M.	189
HOWARD, C. J	Jun.	257
HOWARD, C. P.	M.	86
HOWARD, C. R.	Assoc. M.	189
HOWARD, E. E.	Assoc. M.	189
HOWARD, F. B.	M.	87
HOWARD, J. L.	M.	87
HOWARD, L. T.	Assoc. M.	189
HOWE, C. D	Jun.	257
HOWE, C. E.	Assoc. M.	189
HOWE, E. W.	M.	87
HOWE, F. R	Jun.	257
HOWE, G. E.	M.	87
HOWE, H. F.	Assoc. M.	189
HOWE, H. J.	M.	87
HOWE, H. N.	Jun.	257
HOWE, J. M.	M.	87
HOWE, J. V.	Assoc.	240
HOWE, M. A.	M.	87
HOWE, W. B. W.	M.	87
HOWELL, D. J.	M.	87
HOWELL, F. D., Jr.	M.	87
HOWELL, F. S.	Assoc. M.	189
HOWELL, G. P.	M.	87

		Page
Howell, R. P	Assoc. M.	189
Howell, W. A	Assoc. M.	189
Howells, J. M	M.	87
Howes, C. P	Jun.	257
Howes, D. W	Jun.	257
Howes, F. J	Jun.	257
Howes, R. H	Jun.	257
Howie, H. B. W	Jun.	257
Howson, G. W., Jr	Jun.	257
Hoxie, R. L.	M.	87
Hoyt, H. P	Assoc. M.	189
Hoyt, J. C.	M.	87
Hoyt, J. T N	Assoc. M.	189
Hoyt, W. E	M.	87
Hubbard, I. W	M.	87
Hubbard, W. D	Assoc. M.	189
Hubbell, C. W.	M.	87
Hubbell, G. S	Assoc. M	189
Huber, W. L	Jun.	257
Hudson, C. W	M.	87
Hudson, H. W	Assoc. M.	189
Hudson, J. R	M.	87
Huestis, C. C	Assoc. M.	189
Huff, C. L	Assoc. M.	190
Huggins, W	M.	87
Hughes, D. E.	M.	87
Hughes, F. D	Assoc. M.	190
Hughes, H. J	M.	88
Hughes, H. L	Assoc.	240
Hughes, W. M	M.	88
Hughes, W. R., Jr	Jun.	257
Hull, G. B. G	Jun.	257
Hulse, S. C	Assoc. M.	190
Humphrey, F. L	Jun.	257
Humphrey, R. L	M.	88
Humphreys, A. C	M.	88
Humphreys, C. S	Assoc. M.	190
Humphreys, D. C	M.	88
Hunicke, W. A	Assoc. M.	190
Hunt, A. M	M.	88
Hunt, C. A	Assoc. M.	190
Hunt, C. B.	M.	88
Hunt, C. E	Assoc.	240
Hunt, C. W	M.	88
Hunt, L. A	Assoc. M.	190
Hunt, L. E	Assoc. M.	190
Hunt, R. C	M.	88
Hunt, R. W	M.	88
Hunter, A	Assoc. M.	190
Hunter, J	Assoc. M.	190
Hunter, J. B	M.	88
Hunter, L. L	Jun.	258
Hunter, R. E	Assoc. M.	190
Hunter, T. B	Assoc. M.	190
Hunter, W	M.	88
Hunter, W. H	M.	88
Hunting, E. N	Assoc. M.	190
Huntington, G. D	Assoc. M.	190
Huntington, L. M	Jun.	258
Huntsman, F. C	Jun.	258
Hurdle, R. T	Jun.	258
Hurlbut, C. C	Assoc. M.	190
Hurlbut, H. B	Assoc. M.	190
Hurry, E. H	M.	88
Hurst, G. J.	Assoc.	240
Huss, G. M	M.	88
Hussey, E. B	M.	88
Huston, J. A	Assoc.	240
Huston, T. L	Assoc. M.	190
Hutchings, J. B., Jr.	Jun.	258
Hutchings, W. E	M.	88
Hutchins, E	Assoc. M.	190
Hutchins, J. C	M.	88
Hutchinson, C. T	M.	88
Hutchinson, G. H	M.	88
Hyatt, C.	Assoc. M.	190
Hyde, A. L	M.	88
Hyde, C. G	M.	89
Hyde, E. W., Jr	Jun.	258
Hyde, H. E	Assoc. M.	190
Hyde, J. L	Assoc. M.	190
Hyde, W. H	Assoc. M.	190
Ichinose, K	Assoc. M.	190
Ijams, J. W	Assoc. M.	190
Ilsley, A. B.	Assoc. M.	191
Immediato, G	Assoc. M.	191
Inagaki, H	Assoc. M	191
Ingalls, O. L	M.	89
Ingersoll, C. A	Assoc. M.	191
Ingersoll, C. M., Jr	M.	89
Ingram, E. L	Assoc. M.	191
Ingram, W. E	Assoc. M.	191
Innes, H. C	Assoc. M.	191
Irish, L. W	Assoc. M.	191
Irwin, J. C	M.	89

PAGE
Irwin, O. W. Jun. 258
Isaacs, J. D. M. 89
Ives, A. S. M. 89
Ives, H. C. Jun. 258

Jabelonsky, C. H. Jun. 258
Jackson, D. C. M. 89
Jackson, G. Assoc. M. 191
Jackson, J. F. Assoc. M. 191
Jackson, J. M. Assoc. M. 191
Jackson, T. H. M. 89
Jackson, T. M. M. 89
Jackson, W. M. 89
Jackson, W. B. M. 89
Jacob, T. N. M. 89
Jacobosky, G. G. Jun. 258
Jacobs, C. M. M. 89
Jacobs, J. M. 89
Jacobs, J. L. Jun. 258
Jacobs, R. H. Assoc. M. 191
Jacoby, H. S. Assoc. 240
Jacomb-Hood, J. W. M. 89
Jahncke, E. L. Assoc. M. 191
James, A. R. Assoc. M. 191
James, W. A. M. 89
Jameson, C. D. M. 89
Jamieson, J. A. M. 89
Jamieson, J. Q. M. 89
Janes, G. P. M. 89
Janney, T. G. Assoc. M. 191
Janney, W. D. M. 90
Jansen, E. C. Assoc. M. 191
Janvrin, N. H. Assoc. M. 191
Japp, H. M. 90
Jaques, W. H. M. 90
Jarrett, E. S. M. 90
Jarvis, C. M. M. 90
Jarvis, C. S. Jun. 258
Jaudon, H. S. M. 90
Jaycox, T. W. M. 90
Jenckes, L. B. Assoc. M. 191
Jenkins, J. E. Assoc. M. 191
Jenkins, W. D. M. 90
Jerrard, L. P. Jun. 258
Jervey, H. M. 90
Jewel, L. L. Assoc. M. 191
Jewett, T. E. Assoc. M. 191
Jewett, W. C. M. 90

PAGE
Johannesson, S. Assoc. M. 192
Johnson, A. Assoc. M. 192
Johnson, A. A. Assoc. 240
Johnson, A. L. M. 90
Johnson, A. N. M. 90
Johnson, C. L. M. 90
Johnson, D. C. Jun. 258
Johnson, E. S. Assoc. M. 192
Johnson, F. R. M. 90
Johnson, G. Jun. 258
Johnson, G. A. Assoc. M. 192
Johnson, G. R. Assoc. M. 192
Johnson, J. M. M. 90
Johnson, Lewis E. M. 90
Johnson, Luther E. Jun. 258
Johnson, L. J. M. 90
Johnson, L. S. M. 90
Johnson, M. Assoc. M. 192
Johnson, P. M. 90
Johnson, R. Assoc. M. 192
Johnson, T. H. M. 90
Johnson, W. E. Assoc. M. 192
Johnson, W. S. M. 90
Johnston, A. C. Jun. 258
Johnston, A. W. M. 91
Johnston, C. E. Assoc. M. 192
Johnston, C. T. M. 91
Johnston, H. G. M. 91
Johnston, J. G. Assoc. M. 192
Johnston, J. H. M. 91
Johnston, J. P. Assoc. M. 192
Johnstone, W. B. Assoc. M. 192
Jonah, F. G. M. 91
Jonas, H. F. M. 91
Jones, A. L. M. 91
Jones, B. E. Jun. 258
Jones, F. A. Assoc. M. 192
Jones, G. M. Jun. 258
Jones, G. R. Jun. 258
Jones, H. L. Assoc. M. 192
Jones, H. M. M. 91
Jones, I. P. Jun. 258
Jones, P. Jun. 258
Jones, S. G. Assoc. M. 192
Jones, S. R. Assoc. M. 192
Jones, T. J. Assoc. M. 192
Jones, W. M. 91
Jones, W. A. Assoc. M. 192

Page
Jones, W. H. .... M. 91
Jonson, E. F. .... Assoc. M. 192
Jordahl, A. .... Assoc. M. 192
Jordan, E. C. .... M. 91
Jordan, H. E. .... Assoc. 240
Jordan, W. F. .... Assoc. M. 192
Jorgensen, L. R. .... Assoc. M. 192
Joslin, H. V. .... Jun. 258
Jouett, H. D. .... Assoc. M. 192
Jouine, G. P. F. .... Jun. 259
Jubb, S. A. .... Assoc. M. 193
Judd, F. R. .... Assoc. M. 193
Judd, W. M. .... M. 91
Judell, A. .... Assoc. M. 193
Judson, C. A. .... M. 91
Judson, W. P. .... M. 91
Judson, W. V. .... M. 91
Juengst, H. F. .... M. 91
Just, G. A. .... M. 91

Kabashima, M. .... Assoc. M. 193
Kadono, C. .... M. 91
Kafka, F. P. .... Assoc. M. 193
Kahn, G. E. .... Jun. 259
Kahn, J. .... Assoc. M. 193
Kaltenbach, H. J. .... Assoc. 240
Kareischa, S. de .... M. 91
Karner, W. J. .... Assoc. 240
Karnopp, E. B. .... Jun. 259
Kast, C. N. .... Assoc. M. 193
Kastenhuber, E. G., Jr., Assoc. M. 193
Kastl, A. E. .... M. 91
Katté, W. .... M. 91
Kauffman, V. A. .... Assoc. M. 193
Kauffmann, W. F. .... M. 91
Kaufman, G. .... M. 92
Kawaguchi, T. .... Assoc. M. 193
Keating, E. H. .... M. 92
Keays, R. H. .... Assoc. M. 193
Keefer, C. H. .... M. 92
Keefer, T. C. .... M. 92
Keim, W. B. .... Assoc. M. 193
Keith, C. W. .... Assoc. M. 193
Keith, G. T. .... M. 92
Keith, H. C. .... M. 92
Keith, L. A. .... Assoc. M. 193
Keller, C. .... M. 92

Page
Keller, C. L. .... M. 92
Keller, O. B. .... Assoc. 240
Kellersberger, A. C. .... Jun. 259
Kelley, H. G. .... M. 92
Kelley, J. A. .... M. 92
Kelley, M. DeT. .... Assoc. M. 193
Kelley, W. D. .... M. 92
Kellogg, A. V. .... Assoc. M. 193
Kellogg, C. .... M. 92
Kellogg, N. B. .... M. 92
Kelly, C. W. .... M. 92
Kelly, W. .... Assoc. M. 193
Kelsey, L. C. .... M. 92
Kemp, J. E. .... Assoc. M. 193
Kempkey, A., Jr. .... Jun. 259
Kendall, C. H. .... M. 92
Kendrick, John W. .... M. 92
Kendrick, Julian W. .... M. 92
Kenly, E. M. .... M. 92
Kenly, W. L. .... M. 92
Kennedy, J. .... M. 93
Kennedy, J. H. .... M. 92
Kennedy, J. J. .... M. 92
Kennedy, T. P. B. .... Jun. 259
Kennedy, W. H. .... M. 93
Kenney, E. F. .... M. 93
Kenrick, R. B. .... M. 93
Kent, W. .... M. 93
Kernot, M. E. .... M. 93
Kerr, F. M. .... M. 93
Kerr, H. S. .... M. 93
Kerr, L. Y. .... M. 93
Ketchum, M. .... Jun. 259
Ketchum, M. S. .... M. 93
Ketchum, R. B. .... M. 93
Keys, E. A. .... Assoc. M. 193
Khuen, R. .... M. 93
Kibbe, A. S. .... M. 93
Kiddle, A. W. .... F. 274
Kiehm, C. .... Assoc. M. 193
Kieffer, S. E. .... M. 93
Kielland, S. T. M. B. .... M. 93
Kienle, J. A. .... Jun. 259
Kiersted, W. .... M. 93
Kilkenny, T. D. .... Jun. 259
Killam, C. W. .... Assoc. M. 193
Kimball, F. C. .... M. 93
Kimball, G. A. .... M. 93

		Page
Kimball, G. H	M.	93
Kimball, W. H	Assoc. M.	193
King, A. C	Jun.	259
King, C. C	M.	93
King, C. M	Assoc. M.	194
King, E. E	Assoc. M.	194
King, E. G	Jun.	259
King, E. T.	Jun.	259
King, R. S	Assoc. M.	194
King, H. W	Assoc.	240
King, P. S	M.	93
King, W., Jr	Assoc.	240
King, W. B	M.	94
King, W. S	M.	94
Kingman, L	M.	94
Kingsley, G	Jun.	259
Kingsley, M. W	M.	94
Kinne, G. W	Assoc. M.	194
Kinnear, W. S	M.	94
Kinsley, T. P	M.	94
Kirby, I. H	Assoc. M.	194
Kirchner, P. A	Assoc. M.	194
Kirkham, J. E	Assoc. M.	194
Kirkpatrick, H. B	Assoc. M.	194
Kirkpatrick, W. G	M.	94
Kirkwood, H. C	Jun.	259
Kissack, A. B	Assoc. M.	194
Kittredge, G. W	M.	94
Kittrell, J. W	M.	94
Klapp, E	M.	94
Kleinbeck, A. G	M.	94
Kleinschmidt, H. S	Assoc. M.	194
Klinck, J. H.	M.	94
Klossowski, T. J	Assoc. M.	194
Kluegel, C. H	M.	94
Knap, E. D	Assoc. M.	194
Knap, J. M	M.	94
Knapp, H. M	M.	94
Knapp, L. H	M.	94
Knapp, Z. E	M.	94
Knickerbacker, J	M.	94
Knickerbocker, C. E	M.	94
Knight, C. W	M.	94
Knight, E. K	Assoc. M.	194
Knight, F. B	Assoc. M.	194
Knight, R. W	M.	94
Knight, W. H	M.	94
Knight, W. J	Jun.	259
Knighton, J. A	M.	94
Knobloch, W. E	M.	94
Knoch, J. J	Assoc. M.	194
Knowles, M	M.	95
Knowlton, T. E	M.	95
Knox, S. B	M.	95
Knox, S. L. G	M.	95
Knutson, G. H	Jun.	259
Koch, J. C	Assoc. M.	194
Koenig, A. C	Assoc. M.	194
Koenig, L	Jun.	259
Kohn, A. H	Jun.	259
Kolb, H. J	Assoc. M.	194
Kondo, S	M.	95
Kondo, T	M.	95
Koon, R. E	Assoc. M.	194
Kops, J. de B	M.	95
Kornfeld, A. E	Assoc.	240
Kower, H	M.	95
Kreiner, H. P.	Assoc. M.	194
Krellwitz, D. W.	Assoc. M.	194
Kreuger, I	Assoc. M.	194
Krieger, A. A	Jun.	259
Kriegsman, E. F	Jun.	259
Kroeber, A. T	M.	95
Kuersteiner, E. E	M.	95
Kuichling, E	M.	95
Kummer, F. A	M.	95
Kunz, F. C	M.	95
Kutz, C. W	M.	95
Kwong, K. Y	M.	95
Kyle, G. A	Assoc. M.	194
Labelle, H. F	M.	95
La Chicotte, H. A	M.	95
Lackey, O. F	M.	95
Lafler, W. A	Assoc. M.	194
LaForge, F. W	M.	95
Lahmer, J. A	M.	95
Lake, E. N	M.	95
Lake, O	Jun.	259
Lall, C.	M.	96
Lally, J. M	Assoc.	240
Lamb, E. A	Assoc. M.	195
Lamb, R	M.	96
Lamb, W. A	Jun.	259
Lambert, B. J	Assoc. M.	195
Lambert, W. C	Assoc. M.	195

		Page
Lambie, C. S	Assoc. M.	195
Lamont, C. B.	Assoc. M.	195
Lanagan, F. R.	Assoc. M.	195
Lancashire, F. H.	Assoc. M.	195
Landers, C. S.	Assoc. M.	195
Landon, E. A.	M.	96
Landor, E. J	M.	96
Landreth, O. H.	M.	96
Landreth, W. B.	M.	96
Lane, E. G	Assoc. M.	195
Lane, E. P	Assoc. M.	195
Lane, H. A.	Assoc. M.	195
Lang, O. H	M.	96
Lange, G. A	M.	96
Lange, T. F	Assoc. M.	195
Langthorn, J. S	M.	96
Langton, J	M.	96
Lannan, L. E.	Assoc. M.	195
Lant, F. P.	M.	96
Larimer, R. S	Jun.	259
Larmon, F. P.	Assoc. M.	195
Larrabee, W. D	M.	96
Larrison, G. K	Assoc. M.	195
Larson, C. M.	Assoc. M.	195
Larsson, C. G. E.	M.	96
LaRue, E. C.	Assoc. M.	195
Lasley, C. O	Assoc. M.	195
Latey, H. N	M.	96
Lathbury, B. B.	M.	96
Lathrop, J. C.	Assoc. M.	195
Latta, H. W.	M.	96
Laub, H	M.	96
Laurgaard, O.	Assoc. M.	195
Lavelle, T. M.	Assoc. M.	195
Lavis, F.	M.	96
Lawlor, F. D. H.	M.	96
Lawrence, C. W.	Assoc. M.	196
Lawrence, E. H.	M.	96
Lawson, L. M.	Assoc. M.	196
Lawson, T. R.	M.	96
Lawton, P	Assoc. M.	196
Lawton, W. H.	M.	96
Lawton, W. L.	Assoc. M.	196
Layfield, E. N.	M.	97
Layng, F. R. S	Jun.	259
Layton, H. F	M.	97
Lea, A. B	M.	97
Lea, R. S.	M.	97
Lea, S., Jr	M.	97
Lea, S. H.	M.	97
Leahy, M. J.	Assoc. M.	196
Leake, B. G.	Assoc. M.	196
Leane, W. B.	Assoc M.	196
Leather, B. H.	Assoc.	241
Leavenworth, G. S.	M.	97
Leavitt, C. W., Jr.	M.	97
Leavitt, E. D	M.	97
Leavitt, F. McD	M.	97
Le Baron, J. F.	M.	97
Le Conte, L. J	M.	97
Ledlie, C. H.	M.	97
Ledoux, J. W.	M.	97
Lee, A. L.	Assoc. M.	196
Lee, C. H.	Jun.	260
Lee, D. R.	Assoc. M.	196
Lee, E. A	Assoc. M.	196
Lee, E. H.	M.	97
Lee, E. M.	Assoc. M.	196
Lee, G. W	Assoc. M.	196
Lee, J. L	Assoc. M.	196
Lee, R. H.	Assoc.	241
Lee, W. B	M.	97
Lee, W. S.	M.	97
Leeds, C. T.	Jun.	260
Leefe, F. E.	Assoc. M.	196
Leeper, J. B	Assoc. M.	196
Leeuw, H	Jun.	260
Leffingwell, F. D.	M.	97
Leffingwell, W. H.	M.	97
Leffler, B. R.	Assoc. M.	196
Legaré, B. P.	M.	97
Lehlbach, G.	M.	97
Lehnartz, F. W.	M.	97
Leighton, G.	M.	97
Leighton, M. O	Assoc. M.	196
Leisen, T. A	M.	98
Leland, G. H.	M.	98
Leland, O. M.	Assoc. M.	196
Leland, W. A.	M.	98
Lemcke, K. W.	Jun.	260
Lemen, W. C. S.	Assoc. M.	196
Lentilhon, E.	M.	98
Leonard, C. M.	Assoc. M.	196
Leonard, H. R.	M.	98
Leonard, J. A.	M.	98
Leonard, J. B.	M.	98

Page
Leonard, O. Y. Jun. 260
Lepper, F. W M. 98
Lesley, R. W. Assoc. 241
Letson, T. H. Assoc. M. 196
Lewerenz, A. C M. 98
Lewinson, M. M. 98
Lewis, A. S Assoc. M. 196
Lewis, C., Jr Assoc. M. 197
Lewis, C. B Jun. 260
Lewis, C. C. M. 98
Lewis, C. McK. Assoc. M. 196
Lewis, E. C M. 98
Lewis, E. W M. 98
Lewis, F. H M. 98
Lewis, J. H Assoc. M. 197
Lewis, L. H. Assoc. M. 197
Lewis, M. W. M. 98
Lewis, N. P M. 98
Lewis, R. T. Assoc. M. 197
Lewis, S. F M. 98
Lewis, W Jun. 260
Lewis. W. R Assoc. M. 197
Lex, W. I. Assoc. M. 197
Libbey, J. T Jun. 260
Lichtner, W. O Jun. 260
Lieb, J. W., Jr M. 98
Liebmann, A. Assoc. 241
Lightfoot, W. J Assoc. M. 197
Lillich, J. T. Jun. 260
Lilly, G. W M. 98
Lilly, R. C Jun. 260
Linard, D. J Assoc. M. 197
Lindau, A. E. Assoc. M. 197
Lindenthal, G M. 98
Lindhé, J. B Assoc. M. 197
Lindholm, C. B Assoc. M. 197
Lindsay, R. L. Jun. 260
Lindsey, J. B., Jr. M 98
Lindsey, K Assoc. M. 197
Lindsley, T Jun. 260
Lineberger, W. F. Assoc. M. 197
Linnell, H. P. Assoc. M. 197
Lint, J. A. de Jun. 260
Linton, H M. 99
Lippincott, J. B. M. 99
Lipsey, T. E. L M. 99
Lisman, O. C. Jun. 260
List, C M. 99

Page
Little, G. K. Assoc. M. 197
Littlefield, E. Jun. 260
Livermore, N. B. Assoc. M. 197
Livingston, A. R. M. 99
Livingston, J. I. Assoc. 241
Llewellyn, F. J M. 99
Llewellyn, F. T. M. 99
Lober, J. B. Assoc. 241
Lobo, C Assoc. M. 197
Lochridge, E. E Assoc. M. 197
Locke, C. A M. 99
Locke, F. B. M. 99
Locke, W. W. Assoc. M. 197
Lockwood, J. A. M. 99
Lockwood, J. B. C. M. 99
Lockwood, W. D. M. 99
Loewenstein, J Assoc. M. 197
Lofland, H. F M. 99
Logan, W. S Assoc. M. 197
Lombardo, J. D Assoc. M. 197
Long, C. B Assoc. M. 197
Long, E. McL. Assoc. M. 197
Long, J. C Assoc. M. 198
Long, M. A M. 99
Longley, F. F. Assoc. M. 198
Look, M. J. M. 99
Loomis, H. M. 99
Loomis, T. H. M. 99
Lord, H Jun. 260
Loree, L. F M. 99
Lorenz, G. B Assoc. M. 198
Lorraine, M. J M. 99
Loughran, H. S Jun. 260
Loughran, J. F. Jun. 260
Louwerse, P. M. Assoc. M. 198
Love, A. C Assoc. M. 198
Lovell, E. B. Assoc. M. 198
Lovell, F. W M. 99
Lovell, W. D M. 99
Lovett, G. F. Assoc. M. 198
Low, E M. 99
Low, G. E Assoc M. 198
Lowe, J M. 100
Loweth, C. F M. 100
Lowinson, O. Assoc. M. 198
Lowrie, H. C M. 100
Lowry, J., Jr. Jun. 260
Lowther, B Assoc. M. 198

		Page
Lubarsky, L. H	Jun.	260
Lucas, D. J	M.	100
Lucas, E. W. V. C	M.	100
Lucas, G. L	Assoc. M.	198
Lucius, A	M.	100
Ludlow, J. L	M.	100
Ludlow, J. W	Jun.	260
Ludwig, J. A	Assoc. M.	198
Luiggi, L	M.	100
Lum, D. W	M.	100
Lund, G. A	Assoc. M.	198
Lund, R. L	Assoc. M.	198
Lundberg, J. H	Assoc.	241
Lundgren, E. L	Jun.	260
Lundie, J	M.	100
Lundoff, C. W	Assoc. M.	198
Lupfer, A. McC	M.	100
Lupfer, E. P	M.	100
Lush, C. W	Jun.	260
Luster, W. H., Jr	M.	100
Lydon, W. A	M.	100
Lydston, W. E	Jun.	260
Lyford, O. S., Jr	M.	100
Lyle, W. T	Assoc. M.	198
Lyman, R. R	Assoc. M.	198
Lynch, E. L	Jun.	261
Lynch, M. L	M.	100
Lynch, T. D	Assoc. M.	198
Lynde, C	Jun.	261
Lynn, H. H. E.	Jun.	261
Lyon, H. L	M.	100
Lyon, L. É	M.	100
Lyon, W. C	Assoc. M.	198
Lyons, J. K	M.	100
Lytel, J. L	Assoc. M.	198
MacAllister, D	M.	100
Macartney, M.	Assoc. M.	198
MacCracken, G. G	Assoc. M.	199
MacCrea, D. A	Assoc. M.	199
MacDiarmid, M. S.	Assoc. M.	199
Macdonald, A. A	Assoc. M.	199
Macdonald, C	M.	100
Macfarlane, A. K	Jun.	261
MacGregor, J	Assoc.	241
MacGregor, J. G	Assoc. M.	199
MacGregor, R. A	Assoc. M.	199
MacHarg, W. S	M.	101
Machen, H. B	M.	101
MacIlvaine, F. S	Jun.	261
Mack, E. R	Assoc. M.	199
Mackall, B. F	M.	101
Mackall, J. N	Jun.	261
MacKay, H. M	M.	101
Mackenzie, A	Hon. M.	33
Mackenzie, G. R	Assoc. M.	199
Macklem, N. R	Jun.	261
Macksey, H. V	M.	101
Maclay, E. G	Assoc. M.	199
Maclay, W. W	M.	101
Macnab, G. T	Assoc. M.	199
MacNair, H. J	Assoc. M.	199
MacNaughton, E. B	Assoc. M.	199
MacNeille, P. R	Assoc. M.	199
Macomb, J. de N., Jr	Assoc. M.	199
Macy, E. C	Assoc. M.	199
McBee, V. E., Jr	Assoc. M.	199
McBurney, H	Assoc.	241
McCalla, W. A	M.	101
McCandliss, W. H	Jun.	261
McCann, T. H	M.	101
McCarthy, G. A	M.	101
McCarty, R. J	M.	101
McCaustland, E. J	M.	101
McClave, S. W., Jr	Jun.	261
McClelland, C. L	Assoc. M.	199
McClintock, J. R	Jun.	261
McClintock, J. Y	M.	101
McClintock, W. E	M.	101
McClure, J. C	Assoc. M.	199
McCollom, T. C	M.	101
McComb, C. O	M.	101
McComb, D. E	M.	101
McConnel, W. G	M.	101
McConnell, I. W	Assoc. M.	199
McConnell, J. L	Assoc. M.	199
McCool, D	M.	101
McCord, J. B	Assoc. M.	199
McCormack, E. W	M.	101
McCormick, G. K	M.	101
McCormick, H. G	Assoc. M.	200
McCormick, R. H	M.	101
McCornack, C. W	Assoc. M.	200
McCoy, C. E	Assoc. M.	200
McCoy, S. A	M.	102
McCrickett, T. F	M.	102

Page
McCrory, S. ... Jun. 261
McCrory, T. G. ... Jun. 261
McCulloch, R. ... Assoc. M. 200
McCulloch, R. A. ... M. 102
McCulloh, E. ... M. 102
McCulloh, W. ... M. 102
McCurdy, H. S. R. ... Assoc. M. 200
McDaniel, A. B. ... Assoc. M. 200
McDaniel, G. G. ... Jun. 261
McDargh, H. J. ... Assoc. M. 200
McDonald, H. ... M. 102
McDonald, J. A. ... M. 102
McDonald, W. N. ... M. 102
McDonnell, R. E. ... M. 102
McDonough, J. A. ... Assoc. M. 200
McDonough, M. J. ... Assoc. M. 200
McFetridge, W. S. ... M. 102
McGeehan, P. ... Assoc. M. 200
McGilvray, T. F. ... M. 102
McGonigle, C. J. ... Assoc. M. 200
McGrath, W. ... M. 102
McGregor, R. R. ... Assoc. M. 200
McGrew, A. B. ... M. 102
McHarg, L. ... Assoc. M. 200
McHenry, E. H. ... M. 102
McInnes, F. A. ... M. 102
McIntire, T. B. ... Assoc. 241
McKay, G. A. ... M. 102
McKay, H. ... M. 102
McKay, J. E. ... M. 102
McKeen, B. ... M. 102
McKenney, C. A. ... M. 102
McKenzie, T. ... Assoc. M. 200
McKenzie, T. H. ... M. 103
McKibben, F. P. ... M. 103
McKim, A. R. ... M. 103
McKim, J. A. ... M. 103
McKinney, F. W. ... Jun. 261
McKinstry, C. H. ... M. 103
McLain, L. R. ... M. 103
McLaughlin, J. J. ... M. 103
McLean, A. ... M. 103
McLean, J. P. ... Assoc. M. 200
McLure, N. R. ... Assoc. M. 200
McMath, R. E. ... M. 103
McMeekin, C. W. ... Assoc. M. 200
McMenimen, W. V. ... Jun. 261
McMillan, C. ... M. 103

Page
McMillan, J. G. ... M. 103
McMinn, T. J. ... M. 103
McMorris, D. W. ... M. 103
McMorrow, J. W. ... Assoc. M. 200
McMurtry, G. ... M. 103
McNab, W. ... M. 103
McNaugher, D. W. ... M. 103
McNeal, J. ... M. 103
McNeil, A. J. ... Jun. 261
McNeil, N. C. ... Jun. 261
McNicol, J. A. ... M. 103
McNulty, G. W. ... M. 103
McPherson, R. H. ... Assoc. M. 200
McReynolds, O. O. ... M. 103
McVean, J. J. ... M. 103
Madden, J. H. ... Assoc. M. 200
Madigan, F. W. ... Jun. 261
Magor, H. B. ... Assoc. M. 200
Magruder, F. C. ... Jun. 261
Maier, H. L. ... Assoc. M. 200
Maignen, J. P. A. ... Assoc. 241
Main, C. T. ... M. 103
Mair, J. W. ... Assoc. M. 201
Mais, H. C. ... M. 104
Maitland, A., Jr. ... M. 104
Malcolm, C. W. ... Assoc. M. 201
Malcomson, A. S. ... Jun. 261
Malmros, N. L. ... M. 104
Maloney, J. E. ... M. 104
Malony, W. Le R. ... Jun. 261
Malsbury, O. E. ... Jun. 261
Maltby, F. B. ... M. 104
Malukoff, A. J. ... Assoc. M. 201
Man, A. P. ... M. 104
Manahan, E. G. ... M. 104
Manchester, E. ... Assoc. M. 201
Manley, H. ... M. 104
Manley, L. B. ... M. 104
Mann, J. L. ... Assoc. M. 201
Manning, R. G. ... M. 104
Manning, W. S., Jr. ... Assoc. M. 201
Mansfield, R. J. ... Assoc. M. 201
Manson, M. ... M. 104
Manter, R. B. ... Assoc. M. 201
Mapes, C. M. ... Assoc. M. 201
Marburg, E. ... M. 104
Marden, H. H., Jr. ... M. 104
Marden, W. R. ... M. 104

		Page
Markwart, A. H	Assoc. M.	201
Marple, W. McK	M.	104
Marquand, P	Assoc. M.	201
Marr, W. W	M.	104
Marroquin y Rivera, M	M.	104
Marsh, C. F	M.	104
Marsh, E. L	Jun.	261
Marsh, F. B	Jun.	261
Marsh, J. B	M.	104
Marshall, C. E. D	Assoc. M.	201
Marshall, H. M	M.	104
Marshall, R. A	M.	104
Marshall, R. B	M.	104
Marshall, T. C	Assoc. M.	201
Marshall, T. W	Assoc. M.	201
Marston, A	M.	105
Marstrand, O. J	M.	105
Martin, B. C	Assoc. M.	201
Martin, E. D	M.	105
Martin, J. W.	Assoc. M.	201
Martin, K. L	M.	105
Martin, William	M.	105
Martin, Wisner	M.	105
Martin, W. I	Assoc. M.	201
Martinez, R. A	Jun.	262
Martinez y Reugifo, C. E.,	Assoc. M.	201
Marvin, F. O	M.	105
Marx, C. D	M.	105
Mason, A. J	M.	105
Mason, F	M.	105
Mason, G. C	M.	105
Mason, S. D	M.	105
Mason, S. J	Assoc. M.	201
Massenburg, W. G	Assoc. M.	201
Matamoros, L	M.	105
Matcham, C. A	M.	105
Mather, T. H	M.	105
Matheson, E. G	Assoc. M.	201
Matheson, J. D	Assoc. M.	201
Mathewson, I	M.	105
Mathewson, T. K	M.	105
Matlaw, I. S	Assoc. M.	201
Matson, J. S	Assoc. M.	201
Matthes, F. E	Assoc. M.	202
Matthes, G. H	M.	105
Maughmer, C	Assoc. M.	202
Maupin, E. S	Assoc. M.	202
Maurice, C. S.	M.	105
Maurice, G. H	M.	105
Maury, D. H	M.	105
Maxim, H. S	M.	106
Maximoff, S. P	M.	106
Maxson, F. O	M.	106
Maxwell, J. R	M.	106
May, DeC.	M.	106
May, T. M	Assoc.	241
May, W. A	M.	106
Mayell, A. J	Jun.	262
Mayer, J	M.	106
Mayhew, A. B	Assoc. M.	202
Maynard, H. W	Jun.	262
Mead, C. A	M.	106
Mead, D. W	M.	106
Mead, E	M.	106
Meadowcroft, W	Assoc. M.	202
Means, T. H	M.	106
Mebus, C. F	M.	106
Meek, G. S	Assoc. M.	202
Meem, J. C	M.	106
Mees, C. A	M.	106
Meggy, R. L. G	Assoc. M.	202
Mehren, E. J	Jun.	262
Meier, W	Assoc. M.	202
Meigs, M	M.	106
Melcher, F. O	M.	106
Melick, N. A	Assoc. M.	202
Melius, L. L	Assoc. M.	202
Melliss, D. E	M.	106
Melluish, J. G	Assoc. M.	202
Melville, G. W	Hon. M.	33
Melvin, D. N	M.	106
Menden, W. S	M.	106
Mendenhall, H. D	Jun.	262
Mendiola, M. M	M.	106
Mensch, L. J	M.	107
Mercer, C. H	M.	107
Meredith, W	M.	107
Meriwether, C	Assoc.	241
Merrick, H. B	Assoc. M.	202
Merrill, G. N	M.	107
Merrill, O	Assoc. M.	202
Merrill, O. C	Assoc. M.	202
Merrill, R. H	Jun.	262
Merrill, W. F	M.	107
Merriman, M	M.	107

Page
Merriman, R. M. . . . Jun. 262
Merriman, T. . . . Assoc. M. 202
Merritt, C. E . . . Jun. 262
Merritt, D. S . . . M. 107
Merritt, G . . . F. 274
Merryman, W. C . . . M. 107
Mersereau, C. V . . . M. 107
Mershon, R. D . . . M. 107
Meryweather, H. F . . . M. 107
Mesa, A. E . . . Assoc. M. 202
Metcalf, L . . . M. 107
Metzger, F. L . . . Jun. 262
Meyer, H. C . . . F. 274
Meyer, H. C., Jr . . . Assoc. 241
Meyer, R . . . M. 107
Meyers, A. M . . . Assoc. M. 202
Meyers, C. W . . . Assoc. M. 202
Middlebrook, C. T . . . M. 107
Middleton, R. J . . . Assoc. M. 202
Mieth, R. E . . . Jun. 262
Miles, J. W . . . M. 107
Millard, C . . . Jun. 262
Millard, C. S . . . M. 107
Miller, C . . . Jun. 262
Miller, C. H . . . M. 107
Miller, C. N . . . Assoc. M. 202
Miller, E. F . . . M. 107
Miller, Frank . . . M. 107
Miller, Fritz . . . Jun. 262
Miller, G. S . . . Assoc. M. 202
Miller, Hiram . . . Assoc. M. 202
Miller, Hugh . . . Jun. 262
Miller, H. A . . . M. 107
Miller H. C . . . M. 107
Miller, H. E . . . Jun. 262
Miller, H. L . . . Jun. 262
Miller, M. M . . . Assoc. M. 202
Miller, R. P . . . M. 108
Miller, S . . . M. 108
Miller, S. A . . . Assoc. M. 203
Millis, J . . . M. 108
Mills, A. L . . . M. 108
Mills, A. P . . . Jun. 262
Mills, C. M . . . M. 108
Mills, H. F . . . Hon. M. 33
Miner, C. A . . . M. 108
Miner, E. F . . . M. 108
Miner, J. H . . . Assoc. M. 203

Page
Minniss, G. S . . . Assoc. M. 203
Minor, E. E . . . M. 108
Mirick, A. S . . . Assoc. M. 203
Mischke, A . . . Jun. 262
Mitcham, G. N . . . Assoc. M. 203
Mitchell, C. H . . . M. 108
Mitchell, L. H . . . Assoc. M. 203
Mitchell, S. P . . . M. 108
Mitchell, W. S . . . M. 108
Mitchell, W. W . . . Jun. 262
Mixer, C. A . . . M. 108
Mobberly, H. P . . . Assoc. M. 203
Moberly, F . . . M. 108
Modjeski, R . . . M. 108
Mogensen, O. E . . . M. 108
Mogensen, P . . . M. 108
Mohun, E . . . M. 108
Moir, E. W . . . M. 108
Moisseiff, L. S . . . M. 108
Moler, W. G . . . Assoc. M. 203
Molera, E. J . . . M. 108
Molitor, D. A . . . M. 108
Molitor, F . . . M. 108
Möller, L . . . Assoc. M. 203
Monahan, J. J . . . Assoc. 241
Moncrieff, A. B . . . M. 109
Moncrieff, J. M . . . M. 109
Moncure, W. A . . . M. 109
Monks, J., Jr . . . Assoc. 241
Mönniche, T. B . . . Assoc. M. 203
Monroe, R . . . M. 109
Monroe, W. K . . . M. 109
Monsarrat, N. D . . . Assoc. M. 203
Montero, J. D . . . Jun. 262
Montfort, R . . . M. 109
Montgomery, E . . . Assoc. M. 203
Montgomery, J. A . . . M. 109
Moody, B . . . M. 109
Moody, J. E . . . Assoc. M. 203
Moore, C. E . . . M. 109
Moore, C. G . . . M. 109
Moore, C. H . . . M. 109
Moore, E. J . . . Assoc. M. 203
Moore, F. F . . . M. 109
Moore, J. E . . . M. 109
Moore, J. E. A . . . M. 109
Moore, J. G . . . Jun. 262
Moore, J. W . . . M. 109

Page
Moore, L. E. Assoc. 241
Moore, R. M. 109
Moore, S. W Jun. 262
Moore, W. E. M. 109
Moore, W. H M. 109
Moorehead, T. P. Assoc. M. 203
Moorshead, A. L. Assoc. M. 203
Moorshead, T. C. Assoc. M. 203
Moran, D. E. M. 109
Moran, R. B. Jun. 262
Mordecai, A. M. 109
More, C. C. Assoc. M. 203
Morey, R. Assoc. M. 203
Moritz, C. H. M. 109
Moritz, E. A. Assoc. M. 203
Morley, F. M. 109
Morrill, G. P. Assoc. M. 203
Morrill, G. S. M. 110
Morrill, W. N. Assoc. M. 204
Morris, C. J. A. M. 110
Morris, C. T. M. 110
Morris, D. H. Assoc. 241
Morris, H. G M. 110
Morris, L. V. M. 110
Morris, M M. 110
Morris, W. C. M. 110
Morrison, C. E. Assoc. M. 204
Morrison, C. G. Jun. 263
Morrison, H. J. M. 110
Morrison, H. P. M. 110
Morrison, J. L. Assoc. M. 204
Morrison, T. J. M. 110
Morrow, F. E Assoc. M. 204
Morrow, J. J. M. 110
Morse, B. F. M. 110
Morse, C. A. M. 110
Morse, C. J. M. 110
Morse, C. M. M. 110
Morse, E. K. M. 110
Morse, G. F. M. 110
Morse, H. S. Assoc. M. 204
Morse, W. P. M. 110
Morssen, C. M. Assoc. M. 204
Morton, W. S. M. 110
Moser, A. L. B. Jun. 263
Moses, J. C. M. 110
Mosman, A. T. M. 110
Moss, C. P. Assoc. M. 204

Page
Moss, R. E. Assoc. M. 204
Moss, R. F. Assoc. M. 204
Mosscrop, A. M. M. 110
Mott, W. E. Assoc. M. 204
Mould, G. A. H. Assoc. M. 204
Moulton, G. M. 111
Moulton, O. McK. Jun. 263
Mowlds, E. M. 111
Moxham, A. J. Assoc. 241
Moyer, A Assoc. 241
Mozart, W. J Assoc. M. 204
Muenscher, E. W. M. 111
Mueser, W. M. 111
Muhs, F. R. M. 111
Mulholland, W. M. 111
Müller, E. J. M. 111
Muller, L Assoc. M. 204
Munn, A. M. Assoc. M. 204
Munn, M. A. Assoc. M. 204
Munroe, H. Assoc. M. 204
Münster, A. W. M. 111
Muralt, C. L. de M. 111
Murphy, D. W. M. 111
Murphy, E. C. M. 111
Murphy, J. E Assoc. M. 204
Murphy, J. J. Assoc. M. 204
Murphy, R. L. Assoc. M. 204
Murray, C. W. Assoc. M. 204
Murray, J. F. M. 111
Murray, R. Assoc. M. 204
Murray, S. Assoc. M. 204
Murtaugh, M. M. M. 111
Musson, E. F M. 111
Myers, C. H. M. 111
Myers, C. J. Assoc. M. 204
Myers, E. T. D., Jr. M. 111
Myers, E. W Assoc. M. 205
Myers, G. H Jun. 263
Myers, J. Hays Assoc. M. 205
Myers, J. Henry Assoc. M. 205
Myers, W. M Assoc. M. 205

Nagle, J. C. M. 111
Nash, F. D. Assoc. M. 205
Nauman, G. M. 111
Neal, C. A. Jun. 263
Neale, J. C M. 111
Neeld, C. M M. 111

		Page
Neely, W. R	M.	111
Neff, F. H	Assoc. M.	205
Neher, C. R	M.	111
Neher, F	M.	111
Neilson, G. H	M.	112
Nelson, A. H	Assoc. M.	205
Nelson, A. T	Assoc. M.	205
Nelson, C. L	Assoc. M.	205
Nelson, F. B	Assoc. M.	205
Nelson, J. A	M.	112
Nelson, J. C	Jun.	263
Nelson, W	Assoc. M.	205
Nethercut, E. S	M.	112
Neuhardt, E	Jun.	263
Neumeyer, R. E	Assoc. M.	205
Neville, C. W. J	Assoc. M.	205
Newbegin, P. C	Assoc. M.	205
Newberry, S. B	Assoc. M.	205
Newbrough, W	M.	112
Newell, F. H	M.	112
Newell, H. D	Assoc. M.	205
Newell, J. P	M.	112
Newhall, W. B	Assoc. M.	205
Newman, A. T	Assoc. M.	205
Newman, E	M.	112
Newman, R. M	M.	112
Newton, A. W	M.	112
Newton, G. C	Jun.	263
Newton, R. E	M.	112
Newton, S. D	Assoc. M.	205
Nial, W. A	Assoc. M.	205
Nichol, H. S	Jun.	263
Nichol, J	M.	112
Nichols, A. R	Assoc. M.	205
Nichols, C. Hart	M.	112
Nichols, C. Henry	M.	112
Nichols, C. Hicks	Assoc. M.	206
Nichols, E. J	M.	112
Nichols, H. F	Assoc. M.	206
Nichols, J. R	Jun.	263
Nichols, L. A	M.	112
Nichols, W. A	M.	112
Nicholson, F. L	M.	112
Nicolaysen, A. G	Jun.	263
Nicolls, W. J	M.	112
Nicolson, G. L	M.	112
Nikirk, F. A	Jun.	263
Nikolitch, M	Jun.	263
Nimmo, J. V	Assoc. M.	206
Nixon, C	Assoc. M.	206
Noble, A	M.	112
Noble, C. W	Assoc. M.	206
Noble, F. C	Assoc. M.	206
Noble, T. A	M.	112
Noble, W. E	Assoc. M.	206
Noerr, R. C	Assoc. M.	206
Norboe, P. M	M.	112
Norcross, J. A	M.	112
Norcross, P. H	Assoc. M.	206
Norcross, T. W	Assoc. M.	206
Nordwell, A. W	Jun.	263
Norris, R. V. A	M.	112
Norris, W. H	Assoc. M	206
North, A. T	Assoc. M.	206
North, E. P	M.	112
Northrop, A. A	Assoc. M.	206
Norton, A. G	M.	112
Norton, H. B	M.	113
Noska, G. A	Assoc. M.	206
Nostrand, P. E	M.	113
Noyes, E. B	M.	113
Noyes, H. L	Assoc. M.	206
Noyes, S. H	Jun.	263
Nuebling, E. L	M.	113
Nunn, P. N	M.	113
Nye, A. S	Assoc. M.	206
Nyeboe, M. I	M.	113
Oakes, J. C	Assoc. M.	206
Oakes, L. S	Assoc. M.	206
Oakley, F. T	M.	113
Oakley, G. I	Assoc. M.	206
Oastler, W. C	Assoc.	241
Ober, R. H	M.	113
O'Brien, A	M.	113
O'Brien, D. B	Jun.	263
O'Brien, J. H	M.	113
Obreiter, J. W	Assoc. M.	206
O'Byrne, L. C	Jun.	263
Ockerson, J. A	M.	113
O'Connor, C. J	Assoc. M.	206
O'Connor, J. A	Assoc. M.	206
Odell, F. S	M.	113
Odell, R. I	Assoc.	241
O'Donnell, J. P	M.	113
Oestreich, H. L	M.	113

		Page
Ogawa, U	M.	113
Ogden, H. N	M.	113
O'Hanly, J. L. P	M.	113
O'Hearn, J. L	Assoc. M.	207
Oinouye, C.	Assoc. M.	207
Olberg, C. R	Assoc. M.	207
Olcott, E. E	M.	113
Older, C	Assoc. M.	207
Olds, C	Assoc. M.	207
Olds, W. C	Assoc.	241
Oliver, E	M.	113
Olmsted, A. E	M.	113
Olmsted, F. H	M.	113
Olney, A. C	M.	113
Olney, LaF	M.	113
Omberg, J. A., Jr	Assoc. M.	207
O'Neil, J	Assoc. M.	207
Opdycke, H. G	Assoc. M.	207
Opdyke, S. B., Jr	M.	114
Opsahl, H. T	Assoc. M.	207
Orange, J	M.	114
O'Rourke, J. F	M.	114
Orr, A	Assoc. M.	207
Orrok, G. A	M.	114
Ortiz, E	Assoc. M.	207
Osborn, F. C	M.	114
Osborn, K. H	Jun.	263
Osborn, O. S	Assoc. M.	207
Osborne, G. F. F	Assoc. M.	207
Osbourn, H. V. B	Assoc. M.	207
Osgood, J. O	M.	114
O'Shaughnessy, M. M	M.	114
Ostrander, J. E	M.	114
Ostrom, J. N	M.	114
Ostrup, J. C	M.	114
Otagawa, M	M.	114
Otis, G. E	M.	114
Ott, S. J	Assoc. M.	207
Ottosen, P. H	Jun.	263
Owen, A. E.	Assoc. M.	207
Owen, E. H	Assoc. M.	207
Owen, J	M.	114
Owen, K. D	Jun.	263
Owens, H. K	M.	114
Owens, J. M	Assoc. M.	207
Oxholm, T. S	M.	114
Pace, F	Assoc. M.	207
Packard, R. G	M.	114
Packard, R. G., Jr	Assoc.	241
Paddock, H. C	Assoc. M.	207
Page, L. W	M.	114
Page, W. N	M.	114
Paget, E. W	M.	114
Pagon, W. W	Jun.	263
Paige, J	Assoc. M.	207
Paine, A. B	M.	114
Paine, G. H	Jun.	263
Paine, H. A	Assoc. M.	207
Palmer, F	M.	114
Palmer, G. B	Assoc. M.	207
Palmer, J. E	M.	114
Palmer, J. G	M.	115
Palmer, M. B	Assoc. M.	207
Palmer, W. P	Assoc.	241
Paquette, C. A	Assoc. M.	208
Pardee, J. T	M.	115
Paret, M. P	M.	115
Park, J. C	Assoc. M.	208
Parker, A. F	M.	115
Parker, C. F	Assoc. M.	208
Parker, C. J	M.	115
Parker, F. Y	M.	115
Parker, H	M.	115
Parker, J. C	Assoc. M.	208
Parker, J. L	Jun.	263
Parker, K. E	Jun,	263
Parker, M. S	M.	115
Parker, O. K	M.	115
Parker, P. à M	Assoc. M.	208
Parker, R. D	Assoc. M.	208
Parker, W. P	M.	115
Parks, C. W	M.	115
Parks, O. E	M.	115
Parmley, W. C	M.	115
Parsons, A. L.	Assoc. M.	208
Parsons, A. T	Jun.	263
Parsons, B. H	M.	115
Parsons, C. E	Assoc. M.	208
Parsons, G. W	Assoc.	242
Parsons, H. A	Assoc. M.	208
Parsons, H. C	M.	115
Parsons, H. de B	M.	115
Parsons, R. S	M.	115
Parsons, W. B	M.	115
Paschke, T	M.	115

Page
Patch, H. A. ... Assoc. M. 208
Patch, W. W. ... M. 115
Paterson, C. J. ... Jun. 264
Paterson, H. T. ... M. 115
Patrick, M. M. ... M. 115
Patten, H. B. ... M. 115
Patterson, C. B. ... Assoc. M. 208
Patterson, E. ... Jun. 264
Patterson, I. W. ... Jun. 264
Patterson, J. C. ... M. 116
Patterson, R. Y. ... Assoc. M. 208
Patterson, W. R. ... M. 116
Patton, A. G. ... Assoc. 242
Paul, C. H. ... M. 116
Pawling, G. F. ... Assoc. M. 208
Payne, E. V. R. ... M. 116
Payne, J. H. ... Assoc. M. 208
Payne, W. A. ... M. 116
Payrow, H. G. ... Jun. 264
Peabody, L. H., Jr. ... Jun. 264
Peabody, W. W. ... M. 116
Pearl, J. W. ... M. 116
Pearl, W. ... M. 116
Pearse, L. ... Assoc. M. 208
Pearson, E. J. ... M. 116
Pearson, F. S. ... M. 116
Peary, R. E. ... M. 116
Pease, F. A. ... Assoc. M. 208
Peck, C. F. ... Jun. 264
Peck, J. C. ... Jun. 264
Peck, J. G. ... Assoc. M. 208
Peck, M. H. ... Assoc. M. 208
Pegram, G. H. ... M. 116
Peimbert, A. ... M. 116
Pellissier, G. E. ... Assoc. M. 208
Pemoff, J. J. ... M. 116
Pence, W. D. ... M. 116
Pendlebury, E. ... Jun. 264
Pendleton, D. E. ... Jun. 264
Pendergrass, R. A. ... Assoc. M. 208
Penfield, W. H. ... M. 116
Peotter, R. S. ... Assoc. M. 208
Perkins, A. H. ... Assoc. M. 208
Perkins, C. E. ... M. 116
Perkins, C. P. ... M. 116
Perkins, E. T. ... M. 116
Perkins, P. S. ... Assoc. M. 209
Perley, A. B. ... Assoc. M. 209

Page
Perrilliat, A. ... M. 116
Perrine, G. ... M. 117
Perring, H. G. ... Assoc. M. 209
Perrot, E. G. ... Assoc. M. 209
Perry, C. R. ... M. 117
Perry, F. W. ... Assoc. M. 209
Perry, J. P. H. ... Jun. 264
Perry, L. E. ... Jun. 264
Peters, J. M. ... Jun. 264
Petersen, C. W. ... Assoc. M. 209
Peterson, G. C. ... Jun. 264
Peterson, J. ... Assoc. M. 209
Peterson, P. A. ... M. 117
Pettebone, L. A. ... Assoc. M. 209
Pettee, E. E. ... M. 117
Pettigrew, T. ... M. 117
Pew, A. ... M. 117
Peyton, J. H. ... M. 117
Pfau, J. W. ... Assoc. M. 209
Pfeifer, H. J. ... Assoc. M. 209
Pfeiffer, G. W. ... Assoc. M. 209
Pflueger, A. C. ... Assoc. M. 209
Pharr, H. N. ... M. 117
Phelps, E. B. ... Assoc. 242
Phelps, W. C. ... M. 117
Philips, J. H. ... M. 117
Phillips, Alfred E. ... M. 117
Phillips, Asa E. ... M. 117
Phillips, A. L. ... M. 117
Phillips, F. C. ... Assoc. M. 209
Phillips, H. ... M. 117
Phillips, H. A. ... Assoc. 242
Phillips, H. C. ... Assoc. M. 209
Phillips, J. L. ... M. 117
Phillips, R. H. ... M. 117
Phillips, S. B. ... Assoc. M. 209
Phillips, T. C. ... Assoc. M. 209
Phillips, W. H. ... Assoc. M. 209
Phillips, W. R. ... M. 117
Phipps, L. C. ... Assoc. 242
Pickett, W. D. ... M. 117
Pickwick, E. J. ... Assoc. M. 209
Pierce, F. E. ... M. 117
Pierce, G. A. ... Assoc. M. 209
Pierce, H. ... M. 117
Pierce, J. W. ... Assoc. M. 209
Pierce, P. L. ... Jun. 264
Pierce-Hope, J. ... M. 117

		Page
Pierson, G. S	M.	117
Pihl, O. R	M.	117
Pike, R. A	Jun.	264
Pill, J. R	Assoc. M.	209
Pill, L. M	Jun.	264
Pillet, F. F	Jun.	264
Pillsbury, G. B	Assoc. M.	209
Pinchot, G	Assoc.	242
Piper, A. R	Assoc.	242
Pires do Rio, J	Assoc. M	209
Pistor, G. E. J	Assoc. M.	210
Pitkethly, D. T	Assoc. M.	210
Pitcher, S. H	M.	117
Pitman, F. L	M.	117
Pitts, T. D	Assoc. M.	210
Pitzman, J	M.	118
Plimpton, A. L	M.	118
Plock, A. F	Assoc. M.	210
Plogsted, W. J	Assoc. M.	210
Plummer, H. E	Jun.	264
Poe, H. T., Jr	Assoc. M.	210
Poe, J. R	Assoc. M.	210
Poetsch, C. J	M.	118
Pohl, C. A	Assoc. M.	210
Poland, W. B	M.	118
Polhemus, J. S	M.	118
Polk, A. C	Assoc. M.	210
Polk, W. A	Assoc.	242
Polledo, Y	M.	118
Polleys, W. V	M.	118
Pollock, C. DuB	M.	118
Pomeroy, L. R	Assoc.	242
Pond, H. B	Assoc. M.	210
Pond, H. O	M.	118
Pontzen, E	Cor. M.	33
Poole, C. A	Assoc. M.	210
Poole, J. H	Assoc. M.	210
Poorman, A. P	Assoc.	242
Pope, J. H.	M.	118
Pope, W	M.	118
Popert, W. H	Assoc. M.	210
Porter, D	M.	118
Porter, H. F	Jun.	264
Porter, H. H	M.	118
Porter, H. T	M.	118
Porter, J. E	Jun.	264
Porter, J. M	Assoc. M.	210
Porter, S. G	Assoc. M.	210
Post, C. L	Assoc. M.	210
Post, G. B	M.	118
Post, H. W	M.	118
Post, W. A	M.	118
Post, W. S	Assoc. M.	210
Potter, A	Assoc. M.	210
Potter, C. L	M.	118
Potter, E. J	Jun.	264
Potter, H. L	M.	118
Potter, H. W	M.	118
Potter, J. R	Assoc. M.	210
Potter, W. B	M.	118
Potts, C	Assoc. M.	210
Powell, A. O	M.	118
Powell, A. V	M.	118
Powell, T. J	Assoc. M.	210
Powell, W. J	Jun.	264
Power, G. C	M.	118
Powers, C. V. V	M	118
Powers, J. A	M.	119
Pratt, A. H	Assoc. M.	210
Pratt, H. B.	Assoc. M.	211
Pratt, J. M	Assoc. M.	211
Pratt, M. D	M.	119
Pratt, W. A	M.	119
Prentice, W. H., Jr	Assoc. M.	211
Pressey, H. A.	Assoc. M.	211
Preston, C. H	M.	119
Preston, C. H., Jr	Assoc. M.	211
Preston, H. L	Assoc. M.	211
Preston, H. W	M.	119
Price, P. L	Assoc. M.	211
Price, P. W	Assoc. M.	211
Price, W. G	M.	119
Prichard, H. S	M.	119
Priest, B. B	Assoc. M.	211
Prime, A. C	Assoc. M.	211
Prince, A. D	Assoc. M.	211
Prince, G. T	M.	119
Prindle, F. C	M.	119
Prior, C. H	M.	119
Pritchard, C. M	Assoc. M.	211
Pritchard, J. C	Jun.	264
Pritchard, P. M	Assoc. M.	211
Pritchett, C. M	Assoc. M.	211
Proal, A. B., Jr	M.	119
Proctor, L. J	Assoc. M.	211
Proctor, R. F	Assoc. M.	211

		Page
Prout, H. G	M.	119
Prouty, E. N	Assoc. M.	211
Pruett, G. C	Jun.	264
Pruyn, F. L.	M.	119
Puffer, W. H	M.	119
Puga, G. Beltran y	M.	119
Pugh, De W. P	M.	119
Pugh, M. R.	M.	119
Pullar, W. M.	Assoc. M.	211
Purdon, C. de la C	M.	119
Purdy, C. T	M.	119
Putnam, G. R.	M.	119
Querbach, E	Jun.	264
Quick, A. M.	Assoc. M.	211
Quilty, T. F	Assoc.	242
Quimby, C. H., Jr.	Assoc. M.	211
Quimby, H. H	M.	119
Quinby, C. E	Assoc. M.	211
Quinby, E. R.	M.	119
Quincy, C. F	Assoc.	242
Quinn, R	M.	119
Quinton, J. H	M.	120
Quintus, J C	M.	120
Raasloff, H. de	M.	120
Rablin, J. R.	M.	120
Race, J. M	Assoc. M.	212
Rackle, O. W	Jun.	265
Radenhurst, W. N	M.	120
Raikes, H. P	M.	120
Rainbow, J. R	Assoc. M.	212
Ralston, J. C	M.	120
Ramsdell, R. L	Jun.	265
Ramsey, G. R	Assoc. M.	212
Ramsey, J., Jr	M.	120
Randall, H. I	M.	120
Randle, G. N	M.	120
Randolph, B. S	M.	120
Randolph, I	M.	120
Randolph, J. H., Jr	Assoc. M.	212
Randolph, L. S	M.	120
Randolph, R. I	Jun.	265
Rankin, H. H	Assoc. M.	212
Rannells, C. J	Assoc. M.	212
Ranney, C. G	Assoc. M.	212
Ransome, E. L	Assoc.	242
Ranson, B. W	Assoc. M.	212
Raschbacher, H. G	Jun.	265
Raster, W	Assoc. M.	212
Rathbun, J. C	Jun.	265
Ravenscroft, E. H	Assoc. M.	212
Ray, D. H	Jun.	265
Ray, F. G	M.	120
Ray, G. J	M.	120
Raymond, C. Walker	M.	120
Raymond, C. Ward	M.	120
Raymond, W. G	M.	120
Raynor, C. W	Assoc. M.	212
Rea, S.	M.	120
Reaburn, De W. L.	M.	120
Read, R. L	M.	120
Reber, H. L	M.	120
Redlich, C	M.	120
Reed, A. C	Assoc. M.	212
Reed, C. S	Jun.	265
Reed, D. A	M.	121
Reed, F. E	Jun.	265
Reed, M. E	M.	121
Reed, P. L	M.	121
Reed, R. J	Jun.	265
Reed, W. B	M.	121
Reed, W. B., Jr	Assoc. M.	212
Reed, W. M	M.	121
Reedy, O. T	Assoc. M.	212
Reel, C. G.	Assoc. M.	212
Reeves, C. H	Assoc. M.	212
Reeves, D	M.	121
Reeves, H. E	M.	121
Regester, H. S., Jr	Jun.	265
Reich, P. J.	Assoc. M.	212
Reichardt, W. F	Assoc. M	212
Reichmann, A. F	M.	121
Reid, H. A	Assoc. M.	212
Reimann-Hansen, R. L	Jun.	265
Reimer, A. A	Assoc. M.	212
Reimer, F. A	Assoc. M.	212
Reimer, W. H. V	M.	121
Rennell, H. H	Jun.	265
Renshaw, A. H	M.	121
Reynders, J. V. W	M.	121
Reynolds, A. M	M.	121
Reynolds, J. O	Assoc. M.	212
Reynolds, L. C	Assoc. M.	213
Reynolds, R. A	Jun.	265
Rhett, E. M	Jun.	265

Page
Rhines, G. V. . . . . . M. 121
Rhoades, T. E. . . . . . Assoc. M. 213
Rhodes, F. D. . . . . . Assoc. M. 213
Riblet, B. C. . . . . . M. 121
Rice, G. S. . . . . . M. 121
Rice, H. A . . . . . . Assoc. M. 213
Rice, J. M. T. . . . . . Jun. 265
Rice, R. G. . . . . . Jun. 265
Rice, R. H. . . . . . Assoc. M. 213
Rice, W. P. . . . . . M. 121
Rich, E. D. . . . . . M. 121
Rich, I . . . . . . M. 121
Rich, M. S . . . . . . Jun. 265
Rich, W. M. . . . . . Jun. 265
Richards, A. L. . . . . . M. 121
Richards, J. T. . . . . . M. 121
Richardson, C . . . . . . M. 121
Richardson, C. L . . . . . . Assoc. M. 213
Richardson, J. D. . . . . . Jun. 265
Richardson, J. F. . . . . . Assoc. M. 213
Richardson, J. H . . . . . . Assoc. M. 213
Richardson, R. D. . . . Assoc. M. 213
Richardson, T. F. . . . . . M. 122
Richmond, H. A . . . . . . F. 274
Richmond, J. P. W. . . . Assoc. M. 213
Ricker G. A. . . . . . M. 122
Ricketts, L. D. . . . . . M. 122
Ricketts, P. C. . . . . . M. 122
Rickey, J. W. . . . . . M. 122
Rickon, F. J. H. . . . . . M. 122
Ridgway, R. . . . . . M. 122
Riedel, J. C. . . . . . Assoc. M. 213
Riegel, R. M . . . . . . Jun. 265
Riegler, L. J. . . . . . Assoc. M. 213
Riegner, W. B. . . . . . M. 122
Riffle, F. . . . . . M. 122
Riggs, H. E. . . . . . M. 122
Riggs, M. J. . . . . . M. 122
Riggs, T., Jr. . . . . . Assoc. M. 213
Righter, A. A . . . . . . M. 122
Rightmire, E. D. . . . . . Assoc. M. 213
Rights, E. J. . . . . . Assoc. M. 213
Rights, L. D. . . . . . M. 122
Rindsfoos, C. S. . . . . . Jun. 265
Ripley, B . . . . . . Assoc. M. 213
Ripley, H. C. . . . . . M. 122
Ripley, H. L. . . . . . M. 122
Ripley, J. . . . . . M. 122
Page
Ripley, J. W. . . . . . M. 122
Ripley, T. M. . . . . . Assoc. M. 213
Rippey, S. H. . . . . . M. 122
Riser, K. S. . . . . . M. 122
Ritchie, G. A. . . . . . M. 122
Ritchie, J. . . . . . M. 123
Rittenhouse, H. . . . . . Assoc. M. 213
Rittenhouse, W B . . . . . . M. 123
Ritter, L. E. . . . . . M. 123
Rix, E. A. . . . . . M. 123
Robb, L. A . . . . . . Assoc. M. 213
Robbins, A. A. . . . . . M. 123
Robbins, D. W. . . . . . Assoc. M. 213
Robbins, F. H. . . . . . Assoc. M. 213
Robbins, H. R. . . . . . Assoc. M. 213
Robbins, S. B. . . . . . M. 123
Roberts, A. E. . . . . . Assoc. M. 214
Roberts, E. P. . . . . . M. 123
Roberts, G. T. . . . . . M. 123
Roberts, H. A. . . . . . Assoc. M. 214
Roberts, H. W. . . . . . Jun. 265
Roberts, P., Jr. . . . . . M. 123
Roberts, S. S. . . . . . M. 123
Roberts, V. . . . . . Jun. 265
Roberts, W. J. . . . . . M. 123
Robertson, A. G. . . . . . Jun. 265
Robertson, M. P. . . . . . M. 123
Robinson, A. A. . . . . . M. 123
Robinson, A. F. . . . . . M. 123
Robinson, A. W . . . . . . M. 123
Robinson, E. F. . . . . . Jun. 265
Robinson, E. G. . . . . . M. 123
Robinson, E. W. . . . . . Assoc. M. 214
Robinson, F. M. . . . . . Assoc. M. 214
Robinson, G. L. . . . . . Assoc. M. 214
Robinson, H. D. . . . . . Assoc. M. 214
Robinson, H. F. . . . . . Assoc. M. 214
Robinson, H. H. . . . . . Assoc. M. 214
Robinson, R. T. . . . . . Assoc. M. 214
Robinson, S. W . . . . . . M. 123
Robinson, W. R . . . . . . Jun. 265
Rockenbach, S. D. . . . . . Assoc. M. 214
Rockwell, E. H. . . . . . Assoc. M. 214
Rockwell, J. V. . . . . . M. 123
Rockwell, S. . . . . . M. 123
Rockwood, A. J. . . . . . M. 123
Rockwood, E. F. . . . . . Assoc. M. 214
Rodd, T. . . . . . M. 123

		Page
Rodenbough, J. F	Assoc. M.	214
Rogers, E. H	M.	123
Rogers, G. H	M.	124
Rogers, H. L	Assoc. M.	214
Rogers, T. F	Jun.	265
Rogers, W. A	M.	124
Rohrer, G.	M.	124
Rohrer, J. B	M.	124
Rohwer, H	M.	124
Rollins, A. P	Jun.	266
Rollins, J. W., Jr.	M.	124
Rommel, G., Jr	M.	124
Rommel, W. G	Jun.	266
Rood, H. M.	M.	124
Ropes, H.	M.	124
Rose, C. C	M.	124
Rose, R. V	Assoc. M.	214
Rosenberg, F	Assoc. M.	214
Rosenberg, T	M.	124
Rosencrans, E. J	M.	124
Rosencrans, W. H	M.	124
Rosenthal, A	Assoc. M.	214
Rosewater, W. M	Assoc. M.	214
Ross, A. B	M.	124
Ross, D. W	M.	124
Ross, E. W	M.	124
Ross, F. G	M.	124
Ross, J	M.	124
Ross, T. A	Assoc. M.	214
Rossell, P. F	Jun.	266
Rotch, W	M.	124
Roundey, E. P	Assoc. M.	214
Rourke, L. K	M.	124
Rousseau, H. H	Assoc. M.	215
Rousseau, W. W.	Assoc. M.	215
Rowe, S. McM	M.	124
Rowe, W. L	Jun.	266
Rowell, G. F	M.	124
Rowland, C. B	M.	124
Rowland, C. L	M.	124
Rowland, T. F., Jr.	M.	125
Rowland, W	Assoc. M.	215
Rowse, A. O	M.	125
Roy, R. M	M.	125
Ruddle, J	M.	125
Rue, M. A	Assoc. M.	215
Rugg, W. F	Assoc. M.	215
Ruggles, C. A	Assoc. M.	215
Ruggles, W. B	M.	125
Rundlett, L. W	M.	125
Runyon, W. K	Assoc. M.	215
Ruple, C. P	M.	125
Rusch, H	Assoc. M.	215
Rushmore, D. B.	M.	125
Russell, A. A. M	Jun.	266
Russell, A. S	Jun.	266
Russell, R. L	M.	125
Russell, S. B	M.	125
Russell, S. M.	M.	125
Russell, W. G	M.	125
Rust, C. H	M.	125
Rust, H. B	M.	125
Rust, H. P	Assoc. M.	215
Ruttan, H. N	M.	125
Ryan, M. H	Assoc. M.	215
Ryan, R. R	Jun.	266
Ryan, W. J	Jun.	266
Ryder, E. M. T	M.	125

		Page
Sabin, A. H	Assoc. M.	215
Sabin, A. T	M.	125
Sabin, L. C	M.	125
Sackett, A. J	Jun.	266
Sackett, J. W	M.	125
Sackett, R. L	Assoc. M.	215
Sadler, C. L	Assoc. M.	215
Saeger, C. M	Assoc.	242
Safford, A. T	M.	125
Safford, E. S	M.	125
Safford, H. R	M.	125
Safford, V. P	M.	126
Sample, J. H	M.	126
Sample, W. D	Assoc. M.	215
Sampson, C. B	Assoc. M.	215
Sanborn, F. B	M.	126
Sanborn, J. F	Assoc. M.	215
Sanders, F. N	Assoc. M.	215
Sanders, W. H	M.	126
Sanderson, N. H	Assoc. M.	215
Sando, W. J	M.	126
Sanford, G. O	Assoc. M.	215
Sanford, H. C	Assoc. M.	215
Sanford, W. E	Assoc. M.	215
Sanger, E. P	Assoc. M.	215
Sanger, W. M	Jun.	266
Saph, A. V	Assoc. M.	215

PAGE

Sapp, E. H ... M. 126
Sargent, A. W ... Assoc. M. 216
Sargent, J. A ... Assoc. M. 216
Sarle, O. P ... M. 126
Sarr, F. W ... Assoc. M. 216
Sass, C. W ... Assoc. 242
Saucedo, V ... Jun. 266
Sauer, A. F ... Jun. 266
Sauerman, H. B ... Assoc. M. 216
Saunders, G. C ... Assoc. M. 216
Saunders, W. L ... M. 126
Savage, H. N ... M. 126
Savage, J. L ... Assoc. M. 216
Savage, J. R ... M. 126
Savage, S. M ... Assoc. M. 216
Saville, C. M ... M. 126
Sawtelle, H. F ... Assoc. M. 216
Sawyer, D. H ... Assoc. M. 216
Sawyer, E ... M. 126
Sawyer, F. M ... Assoc. M. 216
Sawyer, G. L ... Assoc. M. 216
Sawyer, J. H ... Jun. 266
Sawyer, W. C ... Assoc. M. 216
Sawyer, W. H ... M. 126
Sax, P. M ... M. 126
Saxe, V. R. P ... Jun. 266
Sayers, E. L ... Jun. 266
Sayles, E. W ... M. 126
Sayles, R. W ... M. 126
Scaife, W. L ... M. 126
Scammell, J. K ... Assoc. M. 216
Scarborough, F. W ... M. 126
Schaeffer, A ... M. 126
Schaeffler, J. C ... Assoc. M. 216
Schall, F. E ... M. 126
Scharschmidt, S. H ... Assoc. M. 216
Scherer, C. L ... M. 126
Schermerhorn, R., Jr. . Assoc. M. 216
Scheuermann, H. J ... Assoc. M. 216
Schlecht, W. W ... M. 126
Schlickeisen, A. A ... Jun. 266
Schmid, F. R ... Jun. 266
Schmid, R. J ... Jun. 266
Schmidt, M. E ... M. 126
Schmitt, E ... Assoc. M. 216
Schmitt, J ... Jun. 266
Schmitz, F. C ... Assoc. M. 216
Schnauber, F. J ... M. 127

PAGE

Schneeweiss, A. E ... M. 127
Schneider, A ... Assoc. M. 216
Schneider, C. C ... M. 127
Schneider, E. J ... M. 127
Schneider, H ... Assoc. M. 216
Schobinger, G ... Jun. 266
Schoder, E. W ... Assoc. M. 216
Schofield, H. A ... M. 127
Scholtz H. F ... Jun. 266
Schrader, F. A ... Assoc. M. 217
Schreiber, J. M ... M. 127
Schroeder, C ... M. 127
Schubert, C. W ... Assoc. M. 217
Schubert, F. C ... M. 127
Schuchart, P. A ... Assoc. M. 217
Schultz, A. L ... M. 127
Schultz, C ... Jun. 266
Schultze, P ... M. 127
Schulze, H. A ... M. 127
Schumann, C. J ... Jun. 266
Schuyler, J. D ... M. 127
Schuyler, M ... Jun. 266
Schwarze, C. T ... Assoc. M. 217
Schwiers, F. W ... Assoc. M. 217
Schwitzer, J. E ... M. 127
Scofield, E. M ... M. 127
Scofield, G. M ... M. 127
Scorgie, J. C ... M. 127
Scott, A. L ... Assoc. M. 217
Scott, A. M ... M. 127
Scott, C. B ... Assoc. M. 217
Scott, E. K ... M. 127
Scott, G ... Assoc. M. 217
Scott, J. K ... Jun. 266
Scott, W. F ... Assoc. M. 217
Scott, W. V ... Jun. 267
Scotten, F ... M. 127
Scovill, E. T ... M. 127
Scribner, G. H., Jr ... Assoc. 242
Scrimshaw, J. F ... Assoc. M. 217
Scripture, A. M ... M. 127
Seabury, G. T ... Assoc. M. 217
Seaman, H. B ... M. 127
Searle, C. D ... Assoc. M. 217
Searle, L. F ... Assoc. M. 217
Searles, W. H ... M. 127
Sears, A. F ... M. 128
Sears, R. H ... Assoc. M. 217

Page
Sears, T. B...........Assoc. M. 217
Sears, W. H. .... M. 128
Seastone, C. V.........Assoc. M. 217
Seaver, J. W................... M. 128
Seddon, J. A...................M. 128
See, G. C .... Jun. 267
Seeley, H. A................Jun. 267
Seery, F. J............Assoc. M. 217
Sekiba, S........ .....Assoc. M. 217
Selander, J. E................M. 128
Selby, O. E.................Jun. 267
Sell, W. D. ....Assoc. 242
Sellew, F. L..................M. 128
Selmer, J. K ....Assoc. M. 217
Selmer, W. L........... ...Jun. 267
Seltzer, H. K.................M. 128
Sengoku, M....................M. 128
Senior, F. S...........Assoc. M. 217
Senior, S. P....... ...Assoc. M. 218
Serber, D. C. ....M. 128
Sergeant, G., Jr............ M. 128
Sesser, J. C ....Assoc. M. 218
Seurot, P. A......... ....M. 128
Severson, O. M .... ..Assoc. M. 218
Sewell, J. S...... .... M. 128
Seyfert, E. E.........Assoc. M. 218
Shafer, J. C. F ....Jun. 267
Shailer, R. A.................M. 128
Shand, G. E...................M. 128
Shand, J......................M. 128
Shaner, H. L..........Assoc. M. 218
Shankland, E. C..............M. 128
Shankland, R. G. ....Jun. 267
Shankland, R. M ....M. 128
Shanks, O. ....M. 128
Shanley, J. R .... Assoc. 242
Shanly, J. M .... M. 128
Shannahan, J. N............ M. 128
Shattuck, O. F..............M. 128
Shaw, A. M............Assoc. M. 218
Shaw, D. J............Assoc. M. 218
Shaw, E. L.. .... M. 128
Shaw, F. H............Assoc. M. 218
Shaw, G. W ....M. 128
Shaw, S. F....................M. 128
Sheal, R. E... ....M. 129
Shearwood, F. P... ....M. 129
Shedd, E. W...................M. 129

Page
Shedd, F. E........... .... .M. 129
Shedd, G. G..... .....Assoc. M. 218
Shedd, J. H................. M. 129
Sheldon, C. S.........Assoc. M. 218
Sheldon, P. ... .Assoc. M. 218
Sheley, H. W.........Assoc. M. 218
Shellenberger, L. R...Assoc. M. 218
Shelley, O. P....... ..... Jun. 267
Shelmire, R. W.......Assoc. M. 218
Shema, J.................. Jun. 267
Shenehon, F. C............. M. 129
Shepard, D. C............ .. M. 129
Shepard, H. H...............M. 129
Shepardson, J. E......Assoc. M. 218
Shepherd, F. C......... .... M. 129
Sheppard, C. A..............M. 129
Sherman, A. L............ .Jun. 267
Sherman, C. W...............M. 129
Sherman, E. C.........Assoc. M. 218
Sherman, H. E......... .....M. 129
Sherman, R. W...............M. 129
Sherman, W. J...............M. 129
Sherrerd, J. M..............M. 129
Sherrerd, M. R..............M. 129
Shertzer, T. B........Assoc. M. 218
Shiebler, M................Jun. 267
Shima, T .... Assoc. M. 218
Shipman, C. E.........Assoc. M. 218
Shiraishi, N ....M. 129
Shire, M. E...........Assoc. M. 218
Shmeleff, T. S..............M. 129
Shoemaker, H...............Jun. 267
Shoemaker, H. I.......Assoc M. 218
Shoemaker, L. H.. ....Assoc. M. 218
Shoemaker, M. N.. ...Assoc. M. 219
Shonk, J. J.. .... Assoc. M. 219
Short, W. A. D........Assoc. M. 219
Shortt, J. H ....Assoc. M. 219
Shryock, J. G.........Assoc. M. 219
Shuman, E. P............... M. 129
Sibert, W. L................M. 129
Sickman, A. F.........Assoc. M. 219
Silva Freire, V. da......... M. 129
Simpson, C. R..............Jun. 267
Simpson, E. R ....Assoc. M. 219
Simpson, G............Assoc. M. 219
Simpson, G. F...............M. 129
Simpson, G. H...............M. 129

Page

Simpson, P. D. .... Assoc. M. 219
Sims, A. V. .... M. 129
Sims C S. .... M. 130
Sims, H. H. .... Jun. 267
Sims, S. .... Assoc. M. 219
Simson, D. .... M. 130
Sinclair, F. O. .... M. 130
Sinks, F. F. .... M. 130
Sinnickson, G. R. .... Assoc. M. 219
Sirrine, J. E. .... M. 130
Sisson, G. A. .... Assoc. M. 219
Sitt, W. T. .... Assoc. M. 219
Sjöström, I. L. .... M. 130
Skelly, J. W. .... Assoc. M. 219
Skillin, E. S .... Assoc. M. 219
Skilton, G. S. .... M. 130
Skinner, F. G. .... Assoc. M. 219
Skinner, F. W. .... M. 130
Skinner, J. F. .... M. 130
Slayton, C. A. .... Assoc. M. 219
Slifer, H. J. .... M. 130
Sloan, D. .... M. 130
Sloan, W. G .... M. 130
Slocum, C. L. .... Assoc. M. 219
Slocum, C. M. .... M. 130
Small, G. .... Jun. 267
Small, J. H., Jr. .... Jun. 267
Smead, R. C. .... M. 130
Smiley, G. R. .... Assoc. M. 219
Smith, Albert. .... Assoc. M. 219
Smith, Albert. .... Assoc. 242
Smith, Augustus. .... M. 130
Smith, A. H. .... Assoc. M. 219
Smith, A. M. .... M. 130
Smith, A. O. .... Assoc. M. 219
Smith, Cecil B. .... M. 130
Smith, Charles B. .... Assoc. M. 219
Smith, C. C. .... Assoc. 243
Smith, C. E. .... Assoc. M. 220
Smith, C. H. .... Jun. 267
Smith, C. V. .... Assoc. M. 220
Smith, Charles W. .... M. 130
Smith, Chester W. .... Assoc. M. 220
Smith, Edgar F. .... Assoc. M. 220
Smith, Edwin F. .... M. 130
Smith, E. G. .... Jun. 267
Smith, E. M. .... Assoc. M. 220
Smith, E. N. .... Jun. 267

Page

Smith, E. R. .... M. 130
Smith, F. B .... M. 130
Smith, F. C .... Jun. 267
Smith, F. H. .... Assoc. 243
Smith, F. L .... Assoc. M. 220
Smith, F. M. .... Jun. 267
Smith, F. P. .... M. 130
Smith, F. V. .... Assoc. 243
Smith, G. E. P. .... Assoc. M. 220
Smith, G. W. .... M. 131
Smith, H. C. .... M. 131
Smith, H. DeW. .... M. 131
Smith, H. E. .... M. 131
Smith, H. S. .... Assoc. M. 220
Smith, H. S. S. .... Assoc. 243
Smith, James. .... M. 131
Smith, Joseph. .... Jun. 267
Smith, J. C. .... Assoc. M. 220
Smith, J. H. .... M. 131
Smith, J. S. .... M. 131
Smith, J. W. .... M. 131
Smith, L. B. .... Assoc. M. 220
Smith, L. C. L. .... M. 131
Smith, L. F. .... Assoc. M. 220
Smith, L. S. .... Assoc. M. 220
Smith, M. A. .... M. 131
Smith, M. deK., Jr. .... Jun. 267
Smith, M. H. .... M. 131
Smith, O. .... M. 131
Smith, P. .... Assoc. M. 220
Smith, R. B. .... Assoc. M. 220
Smith, R. C. .... M. 131
Smith, R. M. .... Jun. 267
Smith, S. G. .... Jun. 267
Smith, S. K. .... M. 131
Smith, T. A. .... Assoc. M. 220
Smith, T. G. .... M. 131
Smith, T. L., Jr. .... Assoc. M. 220
Smith, W. C. .... M. 131
Smith, W. E. .... Assoc. M. 220
Smith, W. F. .... Assoc. M. 220
Smith, W. M. .... M. 131
Smith, W. R. .... M. 131
Smith, W. Sooy. .... M. 131
Smith, W. Stuart. .... Assoc. M. 220
Smith, W. T. .... Assoc. 243
Smoot, E. K. .... M. 131
Snare, F. .... Assoc. 243

Page
Snell, H. B. Assoc. M. 220
Snell, T. C. B. M. 131
Snook, T. E. M. 132
Snow, C. H. M. 132
Snow, F. A M. 132
Snow, F. H. M. 132
Snow, J. B. M. 132
Snow, J. P. M. 132
Snow, W. P. M. 132
Snyder, B., Jr M. 132
Snyder, Charles H. Assoc. M. 220
Snyder, Christopher H. M. 132
Snyder, F. A. Assoc. M. 220
Snyder, G. D. M. 132
Snyder, H. I. Jun. 268
Solomon, G. R. Assoc. M. 221
Somerville, R. M. 132
Sommer, A Assoc. 243
Sonderegger, A. L. M. 132
Sonne, O. M. 132
Sooysmith, C. M. 132
Soper, E. C Assoc. M. 221
Soper, G. A. M. 132
Soper, R. C. Assoc. M. 221
Sorzano, J. F. M. 132
Souder, H. M. 132
Soulé, E. L. Assoc. M. 221
Soulé, F. M. 132
Soule, H. M. 132
Souther, H. M. 132
Souther, T. W. Assoc. M. 221
Southworth, E. A Assoc. M. 221
Spalding, F. P. M. 132
Spalding, W. J Jun. 268
Sparrow, W. W. K. Assoc. M. 221
Spaulding, C. L. M. 132
Speakman, R. E. M. 132
Spear, P. H. Assoc. M. 221
Spear, W. E. M. 133
Spearman, C. Assoc. M. 221
Speed, J. B. Assoc. 243
Speicher, P. M. Assoc. M. 221
Speidel, H. S. Jun. 268
Spencer, H Assoc. M. 221
Spencer, J. C. M. 133
Spencer, L. B Assoc. M. 221
Spencer, T. N. Assoc. M. 221
Spencer, W. T. Assoc. M. 221

Page
Spengler, A. Assoc. M. 221
Sperry, H. M. M. 133
Spicer, V. K. M. 133
Spielman, J. G. Assoc. M. 221
Spiker, W. C Assoc. M. 221
Spilsbury, E. G. M. 133
Splitstone, C. H. Assoc M. 221
Spofford, C. M M. 133
Spooner, A. N. M. 133
Spooner, C. W. Jun. 268
Spooner, H. W M. 133
Sprague, E. L., Jr. Jun. 268
Sprague, E. M. M. 133
Sprague, F. J. M. 133
Sprague, N. S. Assoc. M. 221
Spring, F. J. E. M. 133
Sproul, A. A M. 133
Squire, H. E Jun. 268
Staats, J. H. M. 133
Staats, R. P. M. 133
Stacpoole, S. W. M. 133
Staley, C. M. 133
Stanford, H. R M. 133
Staniford, C. W. M. 133
Stanley, O. E Assoc. M. 221
Stanton, F. C. Assoc. M. 221
Stanton, F. McM. M. 133
Stanton, J. R F. 275
Stanton, R. B. M. 133
Stanton, W. D Jun. 268
Starr, H. H. Assoc. M. 221
Starr, W. H. Jun. 268
Starrett, M. G. M. 134
Stauffer, D. McN. M. 134
Stayton, E. M. M. 134
Stearns, E. B. Assoc. M. 221
Stearns, F. L. Assoc. M. 221
Stearns, F. P. M. 134
Stearns, R. H. Assoc. M. 222
Steece, E. A. M. 134
Steegmuller, C. A. A. Jun. 268
Steere, A. E. Assoc. M. 222
Steese, J. G. Jun. 268
Steffens, W. F. Assoc. M. 222
Stehle, F. C Assoc. M. 222
Stengel, C. H Assoc. M. 222
Stenger, E. Assoc. M. 222
Stepath, C. U. Assoc. M. 222

		Page
Stephens, C. F	M.	134
Stephenson, F. H	Assoc. M.	222
Stephenson, G. T	Jun.	268
Stephenson, S. A., Jr.	Assoc. M.	222
Stern, E. W	M.	134
Stern, I F	M.	134
Stevens, A	Assoc. M.	222
Stevens, E. W	Assoc. M.	222
Stevens, F. S	M.	134
Stevens, G. M.	Assoc. M.	222
Stevens, Horace E	M.	134
Stevens, Howard E	M.	134
Stevens, H. L	Assoc. M.	222
Stevens, J. C	Assoc. M.	222
Stevens, J. F	M.	134
Stevens, P. E	Assoc. M.	222
Stevenson, T. P., Jr	Assoc. M.	222
Stevenson, W. F	Assoc. M.	222
Stevenson, W. L	Assoc. M.	222
Stewart, C. B	Assoc. M.	222
Stewart, C. S	Jun.	268
Stewart, J	Assoc. M.	222
Stewart, J. M	M.	134
Stewart, J. T	Assoc. M.	222
Stewart, J. W	Assoc. M.	223
Stewart, R. D	M.	134
Stewart, S. J	Assoc. M.	223
Stewart, W. J	Jun.	268
Stewart, W. P	Jun.	268
Stickney, G. F	M.	134
Stidham, H	Assoc. M.	223
Stiles, A. I	Jun.	268
Stillwell, L. B	M.	134
Stilson, M. A. O	Assoc.	243
Stirling, V. R	Jun.	268
Stockett, A. W	Assoc. M.	223
Stockman, L. R	Assoc. M.	223
Stockton, J	Assoc. M.	223
Stockton, R. S	Assoc. M.	223
Stoddard, G. C	M.	134
Stoddard, R. F	Assoc. M.	223
Stokes, S. F	Assoc. M.	223
Stone, E. E	M.	134
Stone, E. H	M.	134
Stone, H. M	M.	134
Stone, J. H	Jun.	268
Stone, W. W	Assoc. M.	223
Storer, S. S	Assoc. M.	223
Storey, W. B., Jr	M.	134
Storrow, S	M.	134
Stott, H. G	M.	134
Stout, H. H	Assoc. M.	223
Stow, M	Jun.	268
Stowe, C. B	Assoc.	243
Stowe, H. C	M.	134
Stowell, C. F	M.	135
Stowitts, G. P	Assoc. M.	223
Strachan, J	M.	135
Strachan, R. C	M.	135
Strahan, C. M	Assoc. M.	223
Strathmann, E. C	Assoc. M.	223
Stratton, C. H	Jun.	268
Stratton, G. E	Assoc. M.	223
Strawn, T. C	Assoc. M.	223
Street, L. L	M.	135
Strehlow, O. E	M.	135
Strickler, G. B	M.	135
Strobel, C. L	M.	135
Stroebe, G. G	Assoc.	243
Strong, A. McC	Assoc. M.	223
Strong, C	M.	135
Strong, J. B	Assoc. M.	223
Strong, M. R	M.	135
Strong, S. D	Jun.	268
Strong, W. E. S	Assoc. M.	223
Strouse, W. F	M.	135
Strout, G. S	Jun.	268
Struckmann, H	Assoc.	243
Stuart, A. A	M.	135
Stuart, F. L	M.	135
Stuart, J. L	Assoc. M.	223
Stuart, J. T	M.	135
Stubblefield, G	Assoc. M.	223
Stubbs, L. W	M.	135
Sturtevant, C. W	M.	135
Suarez y Cordoves, P. A.	Jun.	268
Sublette, G. W	M.	135
Sudriers, V. B	Assoc. M.	224
Suhr O. B	M.	135
Sullivan, J. F	Assoc. M.	224
Sullivan, J. G	M.	135
Sumner, H. A	M.	135
Sumner, R. S	M.	135
Sundstrom, A. Y	Assoc. M.	224
Sundstrom, C. A	M.	135
Supplee, J	M.	135

		Page
Sussex, J. W.	Assoc. M.	224
Suter, C. R.	M.	136
Suter, R	Assoc. M.	224
Sutermeister, A. H.	M.	136
Suttle C. B.	Jun.	268
Sutton, C. W.	Assoc. M.	224
Sutton, F.	M.	136
Swaab, S. M.	M.	136
Swain, G. F.	M.	136
Swanker, J. E	M.	136
Swartwout, R. A.	Assoc. M.	224
Swaty, D. Y.	Assoc. M.	224
Sweeney, H. C.	Assoc. M.	224
Sweeney, J. B.	Jun.	268
Sweesy, T. K.	Jun.	269
Sweetland, H. A.	Jun.	269
Sweitzer, N. B.	Assoc. M.	224
Swendsen, G. L.	M.	136
Swensson, E.	M.	136
Swensson, O. J.	Jun.	269
Swett, E. H.	Jun.	269
Swezey, E. C.	M.	136
Swickard, A.	Assoc. M.	224
Swift, W. E.	Assoc. M.	224
Swinburne, G. W	M.	136
Swindells, J. S.	Assoc. M.	224
Sykes, G.	Assoc. M.	224
Sykes, G. W.	Assoc. M.	224
Sylvester, A. H	Assoc. M.	224
Sylvester, F. McC.	M.	136
Sylvester, I. W.	M.	136
Taber, G. A.	M.	136
Tabor, E. F	M.	136
Taft, J. R.	Assoc. M.	224
Taggart, R. C.	Assoc. M.	224
Tainter, F. S.	M.	136
Tait, H.	Assoc. M.	224
Tait, J. G.	Assoc. M.	224
Talbot, A. N.	M.	136
Talbot, E	Assoc. M.	224
Talbot, F. M.	Assoc.	243
Talbott, H. E.	M.	136
Talcott, H. R.	M.	136
Tallman, L.	Assoc. M.	224
Tallman, P. B.	Jun.	269
Tanabe, S.	M.	136
Tappan, R.	Jun.	269
Tarr, C. W	Assoc. M.	224
Tatum, R. L.	Jun.	269
Tatum, S	M.	136
Taubenheim, U	Assoc. M.	224
Taussig, H. P.	M.	137
Taylor, A. J.	Assoc. M.	225
Taylor, B. H	M.	137
Taylor, C. F.	M.	137
Taylor, E. A.	M.	137
Taylor, E. B.	M.	137
Taylor, G. A.	M.	137
Taylor, G. L.	Assoc. M.	225
Taylor, G. McC.	M.	137
Taylor, H	M.	137
Taylor, H. F.	M.	137
Taylor, H. McG	M.	137
Taylor, J., Jr.	Assoc. M.	225
Taylor, J. T.	M.	137
Taylor, L. A.	M.	137
Taylor, N. A.	Assoc. M.	225
Taylor, O. K., Jr.	Assoc. M.	225
Taylor, R. W., Jr.	Assoc. M.	225
Taylor, S. A.	M.	137
Taylor, T. U.	M.	137
Taylor, W. C	Jun.	269
Taylor, W. D.	M.	137
Taylor, W. G	M.	137
Taylor, W. P.	Assoc. M.	225
Tays, E. A. H.	M.	137
Teal, J. E.	Jun.	269
Tebbetts, G. E.	Assoc. M.	225
Tefft, W. W.	Jun.	269
Teichert, A., Jr.	Jun.	269
Teichman, F.	M.	137
Teigen, T. W. R.	Assoc. M.	225
Teilman, I.	M.	137
Temple, E. B.	M.	137
Temple, J. C.	M.	138
Temple, W. H. G.	M.	138
Tenney, G. O.	Assoc.	243
Tenney, W. R.	M.	138
Terrell, W. H	M.	138
Terry, A. H.	Assoc. M.	225
Terry, A. L., Jr.	Jun.	269
Terry, J. H	M.	138
Thacher, E	M.	138
Thackray, G. E.	M.	138
Thanheiser, C. A.	Assoc. M.	225

		Page
Thayer, H. R	Assoc. M.	225
Thayer, R	M.	138
Theban, J. G	Assoc. M.	225
Theodorson, W. A	Assoc. M.	225
Thian, P. E	M.	138
Thoma, J	Assoc. M.	225
Thomas, B. F	M.	138
Thomas, C. A	M.	138
Thomas, C. D	Assoc. M.	225
Thomas, D. G	M.	138
Thomas, E. B	Assoc. M.	225
Thomas, R. D	Assoc. M.	225
Thomas, S. R	Assoc. M.	225
Thomas, W. E	Assoc. M.	225
Thomas, W. M	Assoc. M.	226
Thomes, E. H	Assoc. M.	226
Thompson, A. W	Assoc. M.	226
Thompson, B	M.	138
Thompson, C. H	Assoc. M.	226
Thompson, C. W	Assoc. M.	226
Thompson, E. D	M.	138
Thompson, E. P	Assoc.	243
Thompson, F	M.	138
Thompson, G	M.	138
Thompson, G. S	Jun.	269
Thompson, H. C	M.	138
Thompson, M. J	Assoc. M.	226
Thompson, R. A	Assoc. M.	226
Thompson, S. C	M.	138
Thompson, S. E	M.	138
Thompson, Wilford A	M.	138
Thompson, William A	M.	138
Thomson, A., Jr	Assoc. M.	226
Thomson, E. B	M.	139
Thomson, F. M	Jun.	269
Thomson, J	M.	139
Thomson, R. H	M.	139
Thomson, S. F	Assoc. M.	226
Thomson, T. K	M.	139
Thomson, W. B	Jun.	269
Thorn, A. W	Assoc.	243
Thorn, C. W	Assoc. M.	226
Thornley, J	M.	139
Thrane, M. M	Assoc. M.	226
Throop, A. T	Assoc. M.	226
Throop, G. H	Assoc. M.	226
Thurber, C. D	Assoc. M.	226
Thuringer, C	Assoc. M.	226
Thurston, E. T., Jr	Assoc. M.	226
Tibbals, G. A	M.	139
Tibbals, S. G	M.	139
Tibbetts, F. H	Assoc. M.	226
Tibbetts, F. L	Assoc. M.	226
Tidd, A. W	Assoc. M.	226
Tiffany, N. N	Jun.	269
Tiffany, N. O., Jr	Assoc. M.	226
Tighe, J. L	M.	139
Tilden, C. J	Assoc. M.	227
Tillinghast, F. H	Assoc. M.	227
Tillit, P. E	Jun.	269
Tillson, E. D	Jun.	269
Tillson, G. W	M.	139
Tilmont, P. A. G	Assoc. M.	227
Tilt, G. E	Assoc. M.	227
Timonoff, V. E	M.	139
Tingley, R. H	M.	139
Tinker, G. H	M.	139
Tinkham, R. R	Jun.	269
Tinkham, S. E	M.	139
Tintorer y Giberga, J	M.	139
Tirrell, C. E	Jun.	269
Titsworth, R. B	Assoc. M.	227
Tittmann, O. H	M.	139
Toch, M	Assoc.	243
Todd, A. M	M.	139
Todd, F. H	M.	139
Todd, O. J	Jun.	269
Toensfeldt, H. C. T	Jun.	269
Toll, A. C	Jun.	269
Toll, R. W	Jun.	269
Tollinger, E. C	M.	139
Toltz, M	Assoc. M.	227
Tomlinson, A. T	M.	139
Tomlinson, S	M.	139
Tomkins, C	Assoc.	243
Tompkins, E. De V	M.	139
Tompson, G. M	M.	140
Tone, S. La R	M.	140
Tonkin Thomas, J	M.	140
Tönnesen, F. L. M	Assoc. M.	227
Tönnesen, T	M.	140
Tooker, F. W	Assoc. M.	227
Torrance, W. M	M.	140
Torre, A. de la	Assoc. M.	227
Torrey, J. E	Assoc. M.	227
Touceda, E. A	M.	140

		Page
Tower, J. W.	Assoc. M.	227
Tower, M. L.	M.	140
Towl, F. M.	M.	140
Towle, F.	Jun.	270
Towle, S.	M.	140
Townsend, C. McD.	M.	140
Townsend, F. E.	Assoc.	243
Tozzer, A. C.	Jun.	270
Tracy, L. D.	Assoc. M.	227
Trask, F. E.	M.	140
Tratman, E. E. R.	Assoc. M.	227
Trautwine, J. C., Jr.	Assoc.	243
Travell, W. B.	Assoc. M.	227
Treadway, H. P.	Assoc. M.	227
Treadwell, L.	M.	140
Treadwell, W. A.	Jun.	270
Tretter, G. A.	M.	140
Tribus, L. L.	M.	140
Triest, W. G.	M.	140
Tripp, O. H.	M.	140
Trocon, A. A.	M.	140
Trotter, A. W.	M.	140
Trout, C. E.	M.	141
Trow, F. H.	Assoc. M.	227
Trowbridge, A. L.	Jun.	270
True, A. O.	Jun.	270
Trundle, H. H.	M.	141
Tsuji, T.	M.	141
Tucker, E. A.	M.	141
Tucker, H. F.	Assoc. M.	227
Tucker, L. W.	M.	141
Tucker, R. F.	M.	141
Tucker, W. C.	M.	141
Tuckey, T. W. T.	M.	141
Tudbury, W. C.	Assoc. M.	227
Tudor, C. G.	Assoc. M.	227
Tull, R. W.	Assoc. M.	227
Tunstall, W. P.	Assoc. M.	227
Turley, O. J.	Assoc. M.	228
Turneaure, F. E.	Assoc. M.	228
Turner, A. M.	Assoc. M.	228
Turner, C. A. P.	M.	141
Turner, C. R.	Jun.	270
Turner, D. L.	M.	141
Turner, E. K.	M.	141
Turner, F. P.	Assoc. M.	228
Turner, G. D. B.	Assoc. M.	228
Turner, H. C.	Assoc M.	228
Turner, Le B.	Jun.	270
Turner, N.	M.	141
Turner, N. P.	Assoc. M.	228
Turner, O. H. B.	M.	141
Turner, W. T.	Assoc. M.	228
Turney, O. A.	Assoc. M.	228
Turrill, S. M.	Assoc.	243
Tuska, G. R.	M.	141
Tutein-Nolthenius, R. P. J.	M.	141
Tutherly, G. C.	Jun.	270
Tuthill, J.	M.	141
Tuttle, A. S.	M.	141
Tutwiler, T. H.	M.	141
Twiggs, J. D., Jr.	Assoc. M.	228
Tye, W. F.	M.	141
Tyler, R. D.	Assoc. M.	228
Tyler, R. G.	Jun.	270
Tyler, W. D.	M.	141
Tyler, W. R.	Jun.	270
Tyrrell, W. A.	Assoc. M.	228
Tyson, A. H.	M.	141
Ubsdell, J. A., Jr.	M.	142
Uhler, W. D.	Assoc. M.	228
Uhlig, C.	M.	142
Ulrich, D.	Assoc. M.	228
Ulrich, E. B.	Assoc. M.	228
Ulrich, J. C.	M.	142
Underhill, G. G.	Assoc. M.	228
Underwood, H. W.	Assoc. M.	228
Unger, E. B. L.	Assoc. M.	228
Upham, C. C.	M.	142
Upham, R. D.	Assoc. M.	228
Upson, M. M.	Assoc. M.	228
Urquhart, G. C.	Assoc. M.	228
Usina, D. A.	Assoc.	243
Vail, C. D.	M.	142
Vail, J. J.	Assoc. M.	228
Valle Zeno, C. del	Assoc. M.	228
Value, B. R.	M.	142
Van Alstyne, H. A.	M.	142
Van Buren, J. D.	M.	142
Van Buren, R.	M.	142
Van Buskirk, C. R.	Assoc. M.	229
Vance, A. M.	Assoc. M.	229
Van Cleve, A. H.	M.	142
Vandervoort, B. F.	Jun.	270

		Page
Vandevanter, C. O.	M.	142
Van Etten, L. E.	Assoc. M.	229
Van Frank, P. R., Jr.	M.	142
Van Hoesen, E. F.	M.	142
Van Horne, J. G.	M.	142
Van Horne, J. R.	Jun.	270
Van Keuren, C. A.	M.	142
Van Liew, J. E.	Assoc. M.	229
Van Loan, S. M.	Assoc. M.	229
Van Name, J. M.	Assoc.	243
Vanneman, C. R.	Assoc. M.	229
Van Ness, H. E.	Assoc. M.	229
Van Norden, E. M.	M.	142
Van Norden, R. W.	M.	142
Van Orden, C. H.	M.	142
Van Ornum, J. L.	M.	142
Van Ornum, S. J.	Assoc. M.	229
Van Pelt, S.	Assoc. M.	229
Van Sant, R. L.	M.	142
Van Suetendael, A. O.	Assoc. M.	229
Van Vleck, J.	M.	142
Van Vleck, J. B.	Jun.	270
Van Winkle, E.	M.	142
Van Winkle, E. B.	M.	142
Van Zile, H. L.	Jun.	270
Vaughan, C. H.	M.	143
Vaughan, G. W.	M.	143
Vaughn, G. W.	M.	143
Veatch, N. T., Jr.	Jun.	270
Vedeler, G. H.	Assoc. M.	229
Vehrenkamp, H. W.	Assoc. M.	229
Venable, W. M.	M.	143
Vensano, H. C.	Jun.	270
Vernon, S. B.	Assoc. M.	229
Verrill, G. E.	M.	143
Verveer, E. L.	Assoc. M.	229
Veuve, E. L.	M.	143
Vickers, T. McE.	Assoc. M.	229
Vielé, M. A.	M.	143
Vier, H.	Assoc. M.	229
Villa, M.	Jun.	270
Villalon, J. R.	Assoc. M.	229
Vincent, E. D.	M.	143
Vincent, E. F.	M.	143
Vinton, T. M.	Assoc. M.	229
Vliegenthart, J. C.	Assoc. M.	229
Vogel, J. L.	Jun.	270
Vogleson, J. A.	M.	143
Vogt, J. H. L.	Assoc. M.	229
Volck, A. G.	Jun.	270
von Blücher, C. F. K-M.	Jun.	270
von Emperger, F. E.	M.	143
von Geldern, E.	Jun.	270
von Geldern, O.	M.	143
von Leer, I. W.	M.	143
von Schon, H. A. E. C.	M.	143
von Schrenk, H.	Assoc.	243
von Unwerth, H.	Assoc. M.	229
Voorhees, P.	Assoc. M.	229
Voorhees, T.	M.	143
Vorce, C. B.	M.	143
Vose, R. H.	M.	143
Voynow, C. B.	Assoc. M.	230
Vredenburgh, W., Jr.	Assoc. M.	230
Vrooman, M.	Assoc. M.	230
Wachtel, L.	Jun.	270
Wachter, C. L.	Assoc. M.	230
Wada, Y.	Assoc. M.	230
Waddell, F. C.	Assoc. M.	230
Waddell, J. A. L.	M.	143
Waddell, M.	M.	143
Waddell, N. E.	Jun.	270
Waddell, R. W.	M.	143
Wadsworth, G. R.	M.	143
Wadsworth, H. H.	M.	144
Wadsworth, J. E.	M.	144
Wagner, B. M.	M.	144
Wagner, F. J.	Assoc. M.	230
Wagner, H. E.	Assoc. M.	230
Wagner, J. C.	M.	144
Wagner, S. T.	M.	144
Wagoner, L.	M.	144
Wait, J. C.	M.	144
Wait, O. A.	Assoc. M.	230
Waite, D. C.	Jun.	271
Waite, G. B.	M.	144
Waldo, M. A.	M.	144
Waldron, A. E.	Assoc. M.	230
Waldron, S. P.	M.	144
Walker, C. I.	M.	144
Walker, C. L.	Jun.	271
Walker, E. D.	M.	144
Walker, E. G.	Jun.	271
Walker, E. L.	Assoc. M.	230
Walker, E. M.	Assoc. M.	230

Page
Walker, F. H. ... M. 144
Walker, G. J ... Jun. 271
Walker, J. J. ... Assoc. M. 230
Walker, J. S ... M. 144
Walker, J. W. ... M. 144
Walker, J. W. G. ... M. 144
Walker, M. L. ... M. 144
Wall, E. E ... M. 144
Wallace, H. U ... M. 144
Wallace, J. F. ... M. 144
Wallace, John H. ... M. 145
Wallace, Joseph H. ... M. 145
Wallace, W. McG. ... Assoc. M. 230
Walling, V. R. ... Assoc. M. 230
Walmsley, W. N ... M. 145
Walsh, G. S. ... M. 145
Walter, G. S. ... Assoc. M. 230
Walter, R. F. ... M. 145
Walters, H. R. St. A. .. Assoc. M. 230
Walther, E. ... Assoc. M. 230
Waltman, W. DeW ... Assoc. M. 230
Walton, H. C ... Jun. 271
Ward, C. C ... Assoc. M. 230
Ward, C. D ... M. 145
Ward, E. A. ... Jun. 271
Ward, G. M. ... Jun. 271
Ward, T. M. ... M. 145
Warder, J. H ... Assoc. 244
Wardle, E. B ... Assoc. M. 230
Ware, J ... Assoc. M. 230
Warlow, A. J ... Jun. 271
Warner, E. H. ... M. 145
Warner, F. C ... M. 145
Warner, J. M ... Jun. 271
Warren, H. A. ... Assoc. M. 230
Warren, W. H. ... M. 145
Warrington, H. E. ... M. 145
Washburn, F. S ... M. 145
Washington, W. de H. .. Assoc. M. 231
Wason, L. C ... M. 145
Wasser, T. J ... Assoc. M. 231
Wassner, M. ... Assoc. M. 231
Watanabe, E. ... Assoc. M. 231
Waterbury, L. A ... Assoc. 244
Waterhouse, J ... M. 145
Wathen, B. S ... M. 145
Watkins, F. W. ... M. 145
Watkins, G. A. ... Assoc. M. 231
Page
Watkins, R ... M. 145
Watkins, S. D. ... Jun. 271
Watson, G. L ... Jun. 271
Watson, I. ... M. 145
Watson, J ... F. 275
Watson, M ... Assoc. 244
Watson, Walter. ... Assoc. M. 231
Watson, William ... M. 145
Watson, W. J. ... M. 145
Watson, W. P. ... M. 145
Watt, D. A. ... M. 145
Watt, J. M. G ... M. 145
Watt, J. R ... Assoc. 244
Waugh, W. H. ... Assoc. M. 231
Wauters, C. ... M. 146
Weaver, E. C ... Jun. 271
Webb, De W. C ... M. 146
Webb, G. H. ... M. 146
Webb, W. L. ... M. 146
Webber, C. P. ... Assoc. M. 231
Webber, R. I. ... Assoc. M. 231
Weber, A. H. ... M. 146
Weber, G. A. ... Assoc. 244
Webster, A. L. ... M. 146
Webster, C. E. ... M. 146
Webster F. W. ... Assoc. M. 231
Webster, G. S. ... M. 146
Webster, R. S. ... Jun. 271
Webster W. R ... M. 146
Wedgeworth, D. C. ... Assoc. M. 231
Weeks, W. C ... M. 146
Wegmann, E. ... M. 146
Weidel, J ... Assoc. M. 231
Weidner, C. R ... Jun. 271
Weiland, A. A. ... Assoc. M. 231
Weinhagen, F. ... M. 146
Weiskopf, S. C. ... M. 146
Weiss, A ... Assoc. M. 231
Weller, F. R. ... Assoc. M. 231
Weller, W. E. ... Jun. 271
Welles, E. H. ... Assoc. M. 231
Wells, C. E. ... M. 146
Wells, G. M ... Assoc. M. 231
Wells, J. A. ... Assoc. 244
Wells, J. H. ... M. 146
Wells, L. W. ... M. 146
Welton, B. F. ... Assoc. M. 231
Welton, N. J. ... F. 275

		Page
Wendt, E. F.	M.	146
Wenige, A. E	Assoc. M.	231
Wentworth, C. A	Assoc. M.	231
Wentworth, C. C.	M.	146
Wentworth, G. L	Jun.	271
Wenzell, A. J	M.	146
Wescott, J. V	Assoc. M.	231
West, C. H.	M.	146
West, O. J	Assoc. M.	231
Westinghouse, G.	M.	146
Weston, C. V	M.	146
Weston, E. B	M.	146
Weston, F. S	Jun.	271
Weston, G.	M.	147
Weston, R. S.	Assoc. M.	232
Westover, H. C	Jun.	271
Wetherbee, G. A	M.	147
Wetherill, W. C.	M.	147
Weymouth, F. E.	M.	147
Wheaton, W. R.	Assoc. M.	232
Wheeler, A. C	Assoc. M.	232
Wheeler, D. M	M.	147
Wheeler, E. S.	M.	147
Wheeler, E. T	M.	147
Wheeler, H. R	Assoc. M.	232
Wheeler, L. L	M.	147
Wheeler, R. N	Assoc. M.	232
Wheeler, W.	M.	147
Wheelock, De F. A	M.	147
Whildin, W. G	M.	147
Whinery, S.	M.	147
Whipple, G. C.	M.	147
Whiskeman, J. P	Assoc. M.	232
Whistler, J. T	M.	147
Whitaker W. F	Jun.	271
Whitbeck, L. F	Jun.	271
White, A. B	Assoc M.	232
White, B. E	Assoc. M.	232
White, D. M	Assoc. M.	232
White, F. G	Assoc. M.	232
White, G. C	Assoc. M.	232
White, G. H.	M.	147
White, H. F	M.	147
White, J. G	M.	147
White, L	Assoc. M.	232
White, T. S.	M.	147
White, W. H	Hon. M.	33
White, W. M.	M.	147
White, W. O.	Assoc. M.	232
Whited, W	Assoc. M.	232
Whitfield, J. E	M.	147
Whitford, N. E	Assoc. M.	232
Whitford, R.	M.	147
Whiting, G. W. C.	Assoc. M.	232
Whitman, E. B	Assoc. M.	232
Whitman, N. D	Assoc. M.	232
Whitman, R.	Assoc. M.	232
Whitmer, D. H.	M.	147
Whitney, F. O	M.	147
Whitney, T. B., Jr.	Assoc. M.	232
Whitsit, L. A	Jun.	271
Whitson, A. U	Assoc. M.	232
Whitted, L. R	Assoc. M.	233
Whittemore, D. J.	M.	147
Whittemore, W. F	M.	148
Wickersham, J. H.	Assoc. M.	233
Wickes, E. D	M.	148
Wickes, J. L	Assoc. M.	233
Widdicombe, R. A	Assoc. M.	233
Wiest, J. C	M.	148
Wiggin, E. W	Assoc. M.	233
Wiggin, T. H	Assoc. M.	233
Wiggins, R. R	Assoc. M.	233
Wiggins, W. D	Assoc. M.	233
Wilbanks, J. R.	Jun.	271
Wilcock, F	Assoc. M.	233
Wilcox, C. L	Jun.	271
Wilcox, F.	M.	148
Wilcox, F. E	Assoc. M.	233
Wilcox, F. L	Assoc. M.	233
Wild, H. J	Assoc. M.	233
Wilder, A. D	Jun.	272
Wildes, W. G	Assoc. M.	233
Wiley, A. J.	M	148
Wiley, H. L	Jun.	272
Wiley. R. B.	Jun.	272
Wiley, W. H	M.	148
Wilgus, H. S	Assoc. M.	233
Wilgus, W. J	M.	148
Wilhelm, J. F	Assoc. M.	233
Wilkerson, T. J	Assoc. M.	233
Wilkes, J. K	M.	148
Wilkins, G. S	Assoc. M.	233
Wilkins, W. G	M.	148
Wilkinson, T. L	M.	148
Willard, N. R	Assoc. M.	233

Page
Willard, W. C. .... Jun. 272
Willcomb, G. E .... Jun. 272
Williams, C. C. .... Jun. 272
Williams, C. G .... M. 148
Williams, C. J. R .... M. 148
Williams, C. P. .... M. 148
Williams, D. .... M. 148
Williams, E. G .... M. 148
Williams, F. P .... M. 148
Williams, Harold S .... Jun. 272
Williams, Howard S .. Assoc M. 234
Williams, G. S .... M. 148
Williams, J. P. J. .... Assoc. M. 234
Williams, L. D .... Assoc M. 234
Williams, LeR. D .... Jun. 272
Williams, P. L., Jr ... Assoc. M. 234
Williams, R. B., Jr ... Assoc M. 234
Williams, R. L .... Jun. 272
Williams, S. D., Jr .... M. 148
Williams, S. W .... Assoc. M. 234
Williams, W. F .... M. 148
Williams, W. S ...... Assoc. M. 234
Williamson, C. S ...... Assoc. M. 234
Williamson, F. R .... M. 148
Williamson, F. S .... M. 148
Williamson, S. B .... M. 149
Willis, A. J .... Jun. 272
Willis, H. P .... Assoc. M. 234
Willis, P. .... M. 149
Willoughby, J. E .... M. 149
Wills, A. J. .... Assoc. M. 234
Willson, F. N. .... Assoc. 244
Wilmot, J. .... Jun. 272
Wilmot, S .... Jun. 272
Wilson, C. A. .... M. 149
Wilson, C. B .... M. 149
Wilson, C. C .... M. 149
Wilson, C. W. S. .... M. 149
Wilson, E. B .... M. 149
Wilson, E. H .... M. 149
Wilson, G. L .... M. 149
Wilson, H. F., Jr .... M. 149
Wilson, H. M. .... M. 149
Wilson, H. P .... Assoc. M. 234
Wilson, H. W. .... M. 149
Wilson, J. B. .... Assoc. M. 234
Wilson, P. H .... M. 149
Wilson, P. L .... Assoc. M. 234

Page
Wilson, S. .... Jun. 272
Wilson, T. L .... Assoc. M. 234
Wilson, T. W .... Assoc. M. 234
Wilson, W. E .... Assoc. M. 234
Wilson, W. L .... M. 149
Wilson, W. T. .... Assoc. M. 234
Wilson, W. W. .... Jun. 272
Wiltsee, W. P .... Assoc. M. 234
Wimmer, S. .... M. 149
Winans, L. L .... Jun. 272
Winchester, P. H ..... Assoc. M. 234
Winchester, T. H .... Jun. 272
Windsor, P. B .... M. 149
Winfree, P. B. .... Assoc. M. 234
Wing, C. B. .... M. 149
Wing, F. K .... Assoc. M. 234
Wingfield, N .... M. 149
Winn, W. S. .... Assoc. M. 234
Winslow, A. E .... Assoc. M. 234
Winslow, B. E .... M. 149
Winsor, F. E .... M. 150
Winterhalter, L. P ... Assoc. M. 234
Wintermute, F. C .... Jun. 272
Wise, C. R .... M. 150
Wise, J. H .... Assoc. M. 235
Wise, R. S .... Jun. 272
Wisner, G. M. .... M. 150
Witham, M. E .... Assoc. M. 235
Witherell, F. W ...... Assoc. M. 235
Witmer, F. P .... M. 150
Witmer, J. F .... M. 150
Witt, C. C .... M. 150
Wittstein, H. L .... Jun. 272
Woermann, J. W .... M. 150
Wolcott, C. S .... Assoc. M. 235
Wolf, J. H. G .... M. 150
Wolfe, C. J. .... M. 150
Wölfel, P. L .... M. 150
Wolff, H. H .... Assoc. M. 235
Wolkowyski, A. I .... Jun. 272
Wolstenholme, A. .... M. 150
Wolverton, I. M .... M. 150
Wonson, S. L .... Assoc. M. 235
Wood, A. B .... M. 150
Wood, C. W. .... M. 150
Wood, D. H .... Assoc. M. 235
Wood, E. N .... M. 150
Wood, F. J .... M. 150

7339 172

		PAGE
Wood, G.	Assoc. M.	235
Wood, G. R.	Assoc. M.	235
Wood, H. B.	M.	150
Wood, H. S.	M.	150
Wood, I. S.	M.	150
Wood, J.	M.	150
Wood, R. W.	Assoc. M.	235
Wood, W. B.	Assoc. M.	235
Wood, W. P.	M.	150
Woodard S. H.	M.	151
Woodard, W.	Assoc. M.	235
Woodbury, C. J. H.	M.	151
Woodbury, J. McG.	Assoc.	244
Woodcock, H. W.	Assoc. M.	235
Woodle, A. S., Jr.	Assoc. M.	235
Woodman, A. W.	M.	151
Woodruff, E. L.	M.	151
Woods, A. A.	Assoc. M.	235
Woods, H. D.	M.	151
Woods, R. P.	M.	151
Woodward, E. C.	Assoc. M.	235
Woodworth, R. B.	M.	151
Wooldridge, C. L.	M.	151
Woolley, A. F.	M.	151
Wooten, W. P.	M.	151
Worcester, J. R.	M.	151
Worley, J. S.	Assoc. M.	235
Wormser, M.	Jun.	272
Wortendyke, N. D.	Assoc. M.	235
Wortham, J. R.	Assoc. M.	235
Worthington, C.	M.	151
Wrenn, J. F.	Assoc.	244
Wrentmore, C. G.	M.	151
Wright, A. E.	Jun.	272
Wright, A. W.	M.	151
Wright, C. H.	M.	151
Wright, E. T.	M.	151
Wright, G. C.	Jun.	272
Wright, J.	M.	151
Wright, John B.	Assoc. M.	235
Wright, Joseph B.	M.	151
Wright, R. B.	Jun.	272
Wright, T. J., Jr.	Jun.	272
Wright, T. T.	Jun.	272
Wright, W. B.	M.	151
Wrigley, H. B.	Assoc. M.	235
Wrotnowski, A. F.	M.	151
Wyckoff, C. R., Jr.	Jun.	273
Wygant, R. C.	Jun.	273
Wyman, A. M.	Assoc. M.	236

Yamaguchi, J.	M.	151
Yappen, A.	Assoc. M.	236
Yates, B. C.	Assoc. M.	236
Yates, E. A.	Assoc. M.	236
Yates, J. J.	Assoc. M.	236
Yates, P. K.	M.	152
Yates, W. H.	Assoc. M.	236
Yeatman, C. P.	M.	152
Yeatman, M. E.	M.	152
Yeatman, P.	M.	152
Yen, T. C.	Assoc. M.	236
Yeo, W. A.	Jun.	273
Yereance, W. B.	M.	152
Yonge, S. H.	M.	152
York, H. W.	M.	152
Young, C. G.	Assoc.	244
Young, C. N.	Assoc. M.	236
Young, H. A.	Assoc. M.	236
Young, L. M.	Assoc. M.	236
Young, R. C.	M.	152
Young, S. McC.	Assoc. M.	236
Yuille, N. A.	M.	152

Zabriskie, A. J.	Jun.	273
Zabriskie, A. M.	Assoc. M.	236
Zachry, J. L.	Assoc. M.	236
Zarbell, E.	M.	152
Zesiger, A. W.	M.	152
Ziesing, A.	M.	152
Ziffer, E. A.	M.	152
Zimmermann, W. G.	Assoc. M.	236
Zinn, A. S.	M.	152
Zinn, G. A.	M.	152
Zollinger, L. R.	M.	152
Zook, M. A.	M.	152
Zorn, G. W.	Assoc. M.	236

Total Membership, 5 314.

HOUSE OF THE SOCIETY,

220 West 57th Street.

Cable Address:
"Ceas, New York."

Telephone:
5913 Columbus.

CALENDAR.

1910-11.

DATES OF MEETINGS IN BOLD-FACED TYPE.

FEBRUARY, 1910

S	M	T	W	T	F	S
..	..	1	**2**	3	4	5
6	7	8	9	10	11	12
13	14	15	**16**	17	18	19
20	21	22	23	24	25	26
27	28	..	..	..	..	..
..	..	..	..	..	..	..

MARCH

S	M	T	W	T	F	S
..	..	1	**2**	3	4	5
6	7	8	9	10	11	12
13	14	15	**16**	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	..	..
..	..	..	..	..	..	..

APRIL

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	**6**	7	8	9
10	11	12	13	14	15	16
17	18	19	**20**	21	22	23
24	25	26	27	28	29	30
..	..	..	..	..	..	..

MAY

S	M	T	W	T	F	S
1	2	3	**4**	5	6	7
8	9	10	11	12	13	14
15	16	17	**18**	19	20	21
22	23	24	25	26	27	28
29	30	31	..	..	..	..
..	..	..	..	..	..	..

JUNE

S	M	T	W	T	F	S
..	..	..	**1**	2	3	4
5	6	7	8	9	10	11
12	13	14	**15**	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	..	..
..	..	..	..	..	..	..

JULY

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	..	..	..	..	..	..

AUGUST

S	M	T	W	T	F	S
..	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	..	..	..
..	..	..	..	..	..	..

SEPTEMBER

S	M	T	W	T	F	S
..	..	..	..	1	2	3
4	5	6	**7**	8	9	10
11	12	13	14	15	16	17
18	19	20	**21**	22	23	24
25	26	27	28	29	30	..
..	..	..	..	..	..	..

OCTOBER

S	M	T	W	T	F	S
..	..	..	..	..	..	1
2	3	4	**5**	6	7	8
9	10	11	12	13	14	15
16	17	18	**19**	20	21	22
23	24	25	26	27	28	29
30	31	..	..	..	..	..

NOVEMBER

S	M	T	W	T	F	S
..	..	1	**2**	3	4	5
6	7	8	9	10	11	12
13	14	15	**16**	17	18	19
20	21	22	23	24	25	26
27	28	29	30	..	..	..
..	..	..	..	..	..	..

DECEMBER

S	M	T	W	T	F	S
..	..	..	..	1	2	3
4	5	6	**7**	8	9	10
11	12	13	14	15	16	17
18	19	20	**21**	22	23	24
25	26	27	28	29	30	31
..	..	..	..	..	..	..

JANUARY, 1911

S	M	T	W	T	F	S
1	2	3	**4**	5	6	7
8	9	10	11	12	13	14
15	16	17	**18**	**19**	20	21
22	23	24	25	26	27	28
29	30	31	..	..	..	..
..	..	..	..	..	..	..

NOTE.—Regular meetings are called to order at 8.30 P. M.

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day and Christmas Day.

At the time of going to press the date of the Annual Convention had not been fixed.

NORTHEASTERN UNIVERSITY LIBRARIES
3 9358 00894712 6

NORTHEASTERN UNIVERSITY LIBRARIES
3 9358 00894712 6